SHALLOW GROUND WATER SURVEY

FOR

NORTH AND SOUTH BURBANK UNIT AREA

OSAGE COUNTY, OKLAHOMA

FIELD RECONNAISSANCE, EXISTING DATA REVIEW AND EVALUATION

FOR

PHILLIPS PETROLEUM COMPANY
EXPLORATION & PRODUCTION
NORTHWESTERN REGION
CENTRAL OKLAHOMA AREA
SHIDLER DISTRICT

BY

MICHAEL S. BRANNAN, P.E.
KURT B. HAGEN, AAPG

PHILLIPS PETROLEUM COMPANY

CORPORATE ENGINEERING

BARTLESVILLE, OKLAHOMA

MAY 1987

SHALLOW GROUND WATER SURVEY

FOR

NORTH AND SOUTH BURBANK UNIT AREA

OSAGE COUNTY, OKLAHOMA

FIELD RECONNAISSANCE, EXISTING DATA REVIEW,
AND EVALUATION

FOR

PHILLIPS PETROLEUM COMPANY
EXPLORATION & PRODUCTION
NORTHWESTERN REGION
CENTRAL OKLAHOMA AREA
SHIDLER DISTRICT

BY

MICHAEL S. BRANNAN, P.E.
AND
KURT B. HAGEN, AAPG

PHILLIPS PETROLEUM COMPANY
CORPORATE ENGINEERING
BARTLESVILLE, OKLAHOMA

SEPTEMBER 1987

SHALLOW GROUND WATER SURVEY IN THE NORTH AND SOUTH BURBANK OIL FIELD

INTRODUCTION

A Shallow Ground Water Survey in the vicinity of the North and South Burbank Unitized Oil Fields has been completed. This survey included a reconnaissance survey, water source inventory, literature search, and review of existing data. It is apparent from the results of this survey that the ground water in the area is not used to an appreciable extent. It is also readily apparent that the ground waters in the review area are undependable and are sparsely used. The area is being adequately served by two municipal supplies, a rural water system, and the Phillips Ark-Burbank water system. Only three water wells on the eastern and upgradient perimeter of the North Burbank Unit (NBU) are being used for human consumption. The only other active water well in the NBU, also on the east and upgradient perimeter, is used for chickens and other livestock.

PREVIOUS USE OF GROUND WATER

Shallow ground water has been used in the past, but was abandoned due to contamination or the presence of more accessible water sources. Interviews with long term residents of the area revealed that ground water was never a dependable source and that most residents relied on cisterns connected to roof gutters. Several residents related stories of early day wells which went bad overnight with salt water. During the development of the Burbank oil fields, large numbers of people lived and worked in the area. The town of Whiz-bang, no longer existing, had some 20,000 people. One of the older residents who attended the town school said that the entire town obtained water from cisterns.

DEVELOPMENT OF ALTERNATE WATER SUPPLIES

In 1927, Phillips completed the Phillips Lake and served water to the city of Shidler, the area gasoline plants, and many of the rural residents. In the early 50's Phillips constructed the Ark-Burbank system to provide water to the unit waterflood from shallow wells drilled into the alluvium along the Arkansas River. In 1972, the OK Rural Water District became operational serving many of the other rural residents. These reliable water supplies were selected by the residents over using ground water.

REPORTS OF PAST CONTAMINATION

Based on the stories of the residents and the stream name, Salt Creek, it was assumed the very shallow ground water was of poor quality. Conductivity measurements by EPA and Phillips personnel did not confirm this assumption. When the current results are considered against the background of water contamination reports, the conclusion must be that natural processes have cleansed the systems. It is also apparent that no continuing contamination is occurring.

FRACTURED ROCK AQUIFERS

It was also found that the near surface rocks are heavily fractured. These sedimentary members and their fractures serve as the shallow aquifers in many cases. However these fractured aquifer systems tend to be localized. The storage capacity of these units is primarily in the fractures. It is also apparent that the fractures have a consistent orientation throughout the section from the surface down into the oil producing Burbank sand. The fractures are the second most important structural geology feature in the Burbank area. The dominant structural feature is the westward dip of about 50 feet per mile. In part, the fractures controlled the development of the drainage pattern. Discharge from the fractures into the surface streams maintains the dry weather flow. Recharge into the fractures during the wet season, reduces the wet weather flow of the stream.

EXISTING DATA REVIEW

An extensive literature search was done to find information on the geology and ground water resources of the Burbank area. Most of the works found dealt with oil and gas production. However, many interesting pieces of data were used from this work. The electric logs of several oil wells in the unit provided information about the deeper water quality. Previously unpublished, proprietary work provided significant detail about the geology and the structure of the area. Two theses, David Vosberg 1954, and Kurt Hagen 1972, provided much of the geologic detail. In particular, Hagen's study had an abnormally large amount of information on the occurrences of the fractures. Inquiries to the Indian Public Health Service, the Osage Indian Agency, and the Oklahoma Water Resources Board did not turn up any information on water wells in the Burbank field area. Telephone conversations with water well drillers indicated that the drillers did not believe usable ground water was available in the area.

FIELD RECONNAISSANCE

A five day field reconnaissance located seventy sources of water shown on the map of the review area which is entitled Location Map - Burbank Area (Enclosure 1). The active wells used for human consumption are shown in red. Active wells used for livestock or irrigation are shown in orange. The inactive wells which could potentially be reactivated are shown in blue on the map. Collapsed, plugged, filled, contaminated, or otherwise unusable wells are shown in brown. Many of the inactive wells are abandoned dug wells or cisterns which have been filled or partially filled. The inactive drilled wells which are potentially usable would require extensive work to put them into operation.

CONCLUSIONS

A. The main conclusion of this work is that the ground waters in the immediate vicinity of the NBU and the SBU are essentially unused for the following reasons.

1. The shallow ground water in the NBU is not being used except for a few naturally isolated instances. The use of this ground water is economically infeasible because of the ready availability of alternate reliable supplies of potable water. The users have demonstrated that the ground water is economically replaceable, at current economics, by replacing that source. The number of water well users are quite few in number (about 10 persons). Also, those users are in the northeast corner of the unit and updip from the unit injection wells.
2. The shallow ground water is found in the fractured rocks near the surface and may be only available seasonally in some locations. The fractures provide the collection, storage, and transmission features of the aquifers. These features allow the fractures to drain quickly. With the free water drained, a well would be unlikely to supply sufficient yield for the needs of an average family on a sustained basis. In the Oklahoma Department of Health Regulations, one gallon per minute is the minimum yield necessary for sufficient yield.
3. These fractured aquifers are in thin, westward dipping layers which are hydraulically isolated from one another in the section by shale layers of very low permeability. This provides a low degree of interconnection with other overlying, potential aquifers.

B. The "Z sand " in the SBU contains waters which are not now nor in the reasonably foreseeable future an underground source of drinking water due to the following conclusions.

1. The "Z sand" is a hydraulically interconnected contiguous unit which is consistent spatially under the NBU and SBU.
2. The "Z sand" contains water very much above the 10,000 ppm limit under the NBU and a small portion of the SBU.
3. Any attempt to produce water from the "Z sand" under the SBU would draw the high TDS water from the under the NBU and to the West of the SBU into the wells.
4. Production of water from the "Z Sand" is not economically justifed when the ready availability of other supplies is considered. The costs of drilling 600 to 700 ft, pumping, treating, and distribution from a zone that contains water unfit for human consumption are beyond cost of a rural water connection.

C. The water producing zones deeper than the "Z sand" contain waters which are in excess of 10000 ppm TDS.

HYDROLOGIC FLOW REGIME

LOCATIONS

The Location Map for the Burbank Area, Enclosure 1, shows the location of water sources, drainage, major cultural features and the areal geology. This map can be considered a map of the classification review area. Active water wells used for human consumption have been highlighted red. Active water wells used for livestock or irrigation purposes have been highlighted orange. Inactive water wells have been highlighted blue as have the water supply lakes. Abandoned wells which cannot be reactivated have been highlighted yellow. Cultural features, drainage features, fractures, and boundaries are shown in black. The geologic contacts are identified by black lines with unit designators.

The map answers the location questions about ground water use in the area. In particular, the map clearly shows that human consumption of ground water within the North Burbank Unit area is clearly confined to the northeast corner of the NBU. Outside of the units, the human use of water is adjacent to surface water features. The number of inactive or abandoned wells is indicative of the ready acceptance of more reliable water supplies such as the old Phillips water system, the Shidler city lake, or the rural water district.

To clearly show the oil production and injection wells a separate map was prepared, Enclosure 9, which includes the unit boundaries and certain cultural features for reference. An attempt was made to include these wells on Enclosure 1, but the result was too busy.

SURFICAL GEOLOGY

The Location Map of the Burbank Area shows the surfical geology of the area in more detail than available anywhere else. The map is the product of a combination of Vosberg (1954), Phillips proprietary studies, Hagen (1972&1985), and this study. As detailed later in the geology section most of the surface units are Permian age in the Wolfcampian series.

The surfical geology shown on the Location Map and the Cross-Section, Enclosure 2, show the general dip of the formations to be to the west at 30 to 50 feet per mile. The Structural Contour Map, Enclosure 3, shows the attitude of the formations in the Classification Review area. The dip and general structure provide substantial gradient slope for gravity to drain the formations to the west. For comparison the Salt Creek gradient is 8.5 feet per mile along its channel. The Cross Section clearly demonstrates the consistency of the formation members. This consistency is further demonstrated in the typical logs from the areas where Phillips did structural studies. Four corehole logs are included in this report, one from each of the following areas; Foraker, Fairfax, Pearsonia, and Wynona (Enclosures 4, 5, 6, and 7 respectively). These corehole logs adequately depict the lithology of the Burbank area.

CROSS SECTION

The Cross-Section, Enclosure 2, shows the separate and distinct formations and members of the geology. It is obvious from inspection of the section, that the contiguous shale sections separate the limestones into individual hydrologic units. The US Geological Survey lumped the section from the Admire Group up through the Wellington Formation as one aquifer. As a broad classification such an assumption is reasonable because the limestones would tend to behave in a similar fashion even though they are distinct members. Also, if a well in the section intercepted several different units, it would be unlikely to develop sufficient yield for a reasonable public water supply. It is probable that cross flow would likely occur allowing the intermixing of waters and probably water loss into a "thief zone". The geology of the area is discussed further in the geology section of this report.

FRACTURES

Fractures in the limestones form and influence the major hydraulic features of the unit. Hagen (1972) found that the fractures controlled the drainage pattern and could be discerned from the Aero Service Corporation aerial photos made for the structural mapping project. Hagen mapped and classified some 43,330 fractures in the review area. These fractures are shown as the many short straight lines on the Location Map. The map and the aerial photos show the exposed fractures. The thin, Shidler series soils are well drained because of the extensive fracture underdrain system. In the spring, vegetation growth over a fracture is much more extensive and verdant than away from the fracture. This makes it possible to trace the fractures on the ground and in the aerial photos. In much of the unit, the fractures are hidden under the shales. However, the fractures continue throughout the member. There are fractures in the shale, but fractures in the shale tend to heal and were not exposed in the shale outcrops examined. Thus the fractures in the shales are much less permeable than the fractures in the limestones. Fractures in the shale are more permeable than the shale itself. The permeablility for each instance have not been quantified. One piece of evidence of the shales' permeability is that much of the light fractions escaped from the Burbank sands i.e.; the reservoir did not have a natural gas drive cap. The natural gas produced from the reservoir was from gas in solution in the Burbank sand reservoir fluids. It is reasonable to assume that gas was formed in the shale under the Burbank sand and that the free gas cap escaped through the fractures but the oil was trapped.

As shown by the fracture orientation rosette, the majority of the fractures are oriented North 70 East. To complete the orthogonal set of primary fractures a second set is oriented North 25 West. As shown by the fracture rosette there are far fewer of the N25W fractures. Hagen indicates that the probable cause of these fractures was a torsion of the entire block of earth comprising northeast Oklahoma and southeast Kansas. Such a torsion system of fractures would account for the consistent system of fractures in the area from the surface down through the Burbank sand. Injection tests in the Burbank sand confirm the fracture orientation at depth. Experience in the early waterflood of the

Burbank showed that injection in the NBU pressured up the Stanley stringer to the east suggesting that the direction of flow was towards the east. Elsewhere in the unit, early breakthrough of injected water usually occurred in an ENE direction parallel to the orientation of the surface fractures.

FRACTURE HYDROLOGY

On close inspection of the location map and the aerial photos, it is apparent that in most instances, the surface flow of rain water would be intercepted by a fracture after a short distance. The water would enter the fracture and then flow along the fracture. In the areas where many fractures are exposed, the percentage of water actually recharged to the fractured units must be extremely high. The water transmission characteristics of these rock units are extremely high due to the density, orientation, and pattern of the fractures. Essentially, the fracture system operates like a system of parallel pipes transmitting the water flow to the west south west. The overland flow of water is intercepted by the fractures and percolates underground. Because of the fracture orientation and the westward dip, flow is established. The pore spaces in the limestone and in the fill material of the fractures act as storage for the water and as the transmission space. The porosity and transmissivity of the limestones is much less than that of the fracture filling material. Although no tests were performed, it is probable that the porosity and transmissivity is three orders of magnitude less than that of the fracture filling material. The fractures fill with water quickly and move the water underground. When the fractures contain water, the water slowly moves into the limestone pores to be stored. When recharge ceases the fractures begin to drain and the limestone pores release water slowly. This slow release from the pores extends the fracture flow period. Where the fractures containing water outcrop they form springs. Some of these springs were developed for water supply. One spring found during the reconnaissance was flowing substantially. The flow was likely the result of a wet fall and winter. As can be seen in the Cross Section, the dipping limestones often intersect streams. Discharge from the fractures forms much of the baseflow of the streams. Recharge from the streams fills the fractures which then transmit water downdip or act as storage for the stream. In dry weather, stored water is released to the stream.

Hydrologically, there is a moderate degree of interconnection between the streams and the bedrock due to the fractures. The interconnection exists only where the fractured rocks outcrop within the banks of the stream. If the outcrop is above the stream bed, the fractured rocks only discharge to springs or seeps and the water enters the stream. During the reconnaissance in January and February 1987, the water flow in Hay and Salt Creeks appeared to remain at a higher level than the drainage area should apparently sustain. Without the fracture storage, the water levels in the streams should peak fairly quickly and then recede quickly. This would be especially true if there were no bank storage. The fractured rock does act as bank storage for the streams. It was also apparent that dry weather flows are very much less than the flows observed during the reconnaissance. Few bridges are used in the unit area, many of the stream crossings even on Salt Creek are fords.

Several of the fords had pipe to carry the dry weather flow. During the reconnaissance it was impossible to determine how many or what size pipes were in the ford. Several of the minor fords on the oil field lease roads were in daily use. The regular use of fords indicates that the average or base stream flow is much less than the observed flow. Such occurrences indicate that the total volume of bank or fracture storage available to maintain stream flow is relatively small.

GROUND WATER OCCURRENCE IN INDIVIDUAL MEMBERS

Table I: Burbank Unit Area Water Sources lists the number of water sources, past and present, for each of the geologic units and associated formations. Of the seventy-four listed sources in the classification review area, only three wells in the unit are used for human consumption. Those three wells are upgradient of injection well activity. The other wells in the Burbank area used for human consumption are more than two miles from the unit boundary and are closely associated with surface water features.

Table II: Detailed Listing of Burbank Unit Area Water Sources lists data about the seventy-four existing or abandoned water sources in the Burbank area. Details such as owner, location, well description, construction method, producing formation, and usable condition are provided in the table. Some information was not available for some wells. In some instances, the reports of residents or other parties were relied on and the actual well was not visited. These wells are spotted and numbered on the Location Map, Enclosure 1, for reference to the table. Usable wells were defined as a well which could be reactivated by installing a pump or reactivating an existing pump. Seventeen of these inactive but potentially usable wells were located. Where the owner was contacted, the reason for non-use was preference for rural water.

The following paragraphs describe the ground water occurrence and potential in the individual rock units.

Cottonwood Limestone

The first potentially water bearing unit in the section is the Cottonwood member of the Beattie Limestone. Only one abandoned well apparently tapped the Cottonwood, that well has been filled. See well 8 on the water source table.

Eskridge Shale

In the north end of the NBU, the surface rock is primarily the Eskridge shale of very low permeability. The Eskridge is a tight confining layer to the Neva limestone and the thin limestone within the shale. Six of seven abandoned or existing water wells in the Eskridge apparently tapped the thin limestone member. The seventh is near Mud Creek and may have been interconnected. Three of the wells supply water for human consumption. Of the other four, two are filled and two could be reactivated. Water is certainly not contiguous in the shale because wells in the northeast corner of NBU range in performance from slightly artesian with almost continuous production to a dry hole a few hundred feet from two producing water wells.

Neva Limestone

The Neva limestone member of the Grenola Limestone formation apparently supplied ten of the abandoned or existing wells located in the reconnaissance. Two of the wells are within ten feet of each other and can be pumped dry in half an hour. The owner obtains drinking water from the rural water district. The wells are used for garden irrigation and intermittent livestock watering. One inactive well in Section 30 T26N R6E was only used for garden irrigation and would require a new pump to reactivate. Three inactive Neva wells in Section 18 T27N R6E could be reactivated. Two inactive Neva wells in Section 11 T27N R5E are polluted by sewage and are not usable. The abandoned Webb City School well/cistern also receives surface water runoff and is not usable. A dry hole in the SW/SE/SW Section 6 T27N R6E was reported to penetrate the Neva and found no water. Water use from the Neva was apparently localized and found primarily north of Webb City. In the southern part of the NBU, the Neva is apparently well drained and water does not accumulate in the member except under local structural conditions.

Bennett Limestone

The Bennett limestone member of the Red Eagle Limestone formation apparently supplied water to eight abandoned or existing wells located in the reconnaissance. One of these wells is actually a water filled, abandoned, limestone quarry in Section 31 T26N R5E which serves as the back up supply for the city of Burbank. Two shallow, dug wells in the Bennett in Section 25 T26N R5E are immediately adjacent and 150 feet down stream of a sizeable pond. One of those wells serves a single resident. An inactive well in Section 5 T26N R6E is potentially usable. A substantial spring was found in Section 5 T26N R6E issuing from the fractures in the Bennett. The resident who showed us the spring said the flow decreases very significantly during dry weather. There were no other obvious springs along the outcrop. An active well used for livestock was found just southeast of Shidler. This well is down gradient of a sizable stock pond which is probably interconnected to the Bennett. The well owner said the house and drinking water was obtained from the rural water district. On a hill a short distance west of Phillips Lake, another abandoned, filled dug well was located. A small spring located in the NW/NW/SW Section 13 T26N R5E serves livestock in a barn. This spring is west of Salt Creek about one and a half miles from the unit boundary. Water from the Bennett in the unit appears to be localized and the ground water flow in the fractured limestone is transient due to the gravity drainage along the dip.

Johnson Shale

A sand lens in the Johnson shale is apparently the source of water for two inactive wells in the SE Section 6 T26N R5E. Both wells are inactive, but could be used for livestock if the owner wishes. One of the wells is down gradient of a farm pond.

Long Creek Limestone

The Long Creek limestone member of the Foraker Limestone supplied water to ten abandoned or existing wells located during the reconnaissance. Six of the wells are located on the west bank of Salt Creek in the city of Burbank. The city water superintendent said that all of the wells were contaminated during the flooding in the fall of 1986. The city used its back up supply from the old quarry and served the other users. He said most of the other well owners in the town were avoiding the cost of city water. In particular, the others had fairly large gardens where they used well water. Because the limestone outcrops in Salt Creek immediately to the east, these wells have a high degree of interconnection with the creek. A resident on the east side of Salt Creek reported that the water level in the old well in her yard fluctuated with the water level in Salt Creek. Her well which also taps the Long Creek limestone has not been used for over forty years because of the presence of white worms in the water. An inactive well which tapped the Long Creek limestone in the SE/SE/NE Section 18 T26N R6E had a pump and could be reactivated. The owner/residents said they used and preferred the rural water system water. An abandoned, filled dug well which also apparently tapped the Long Creek limestone was found in the SW/SW/NW Section 18 T26N R6E. An inactive well which tapped the Long Creek limestone in the NW/NE/SW Section 13 T26N R5E was found a short distance from the Bennett spring in a barn west of Salt Creek. All of the wells which apparently tap the Long Creek limestone are a short distance from Salt Creek. It is evident that at least a moderate degree of interconnection exists between the wells and the creek.

Hughes Creek Limestone

The Hughes Creek limestone member of the Foraker Limestone formation supplied water to nine abandoned or existing wells in the area. The owner of two wells in the SE Section 18 T26N R6E which apparently tap the member reported that one well was not used because of poor quality and the other was a poor producer of water. An old field office, shop, and warehouse in the NE/NE/SE Section T26N R6E formerly obtained water from a well tapping the Hughes Creek. Two abandoned wells in the Hughes Creek limestone located in the SW/NW/SW Section 8 T26N R6E immediately adjacent to Salt Creek were reported to have been dozed in by their owner to eliminate a safety hazard. An abandoned, developed spring was found in the SW/SW/SW Section 4 T26N R6E to be producing a trickle flow of water from the Hughes Creek limestone. An abandoned dug well in the SE/SW/SE Section 4 T26N R6E contained a lot of junk. Another abandoned dug well in the SW/SE/SE Section 4 T26N R6E was behind an abandoned home and apparently had not been used for a long time. Phillips Lake may be in contact with the Hughes Creek limestone outcrop. The lake is upgradient of the NBU injection well activity.

Americus Limestone

The Americus limestone member of the Foraker Limestone formation supplied water to two abandoned wells in the area. Both of these wells are in the SE Section 36 T26N R5E on the Wilkin Ranch. They are in the Salt Creek valley within a few hundred yards of the stream. It is highly likely that the wells production was interconnected with the stream.

Brownville Limestone

The Brownville limestone of Pennsylvanian age only supplied water to one abandoned well in the review area. That well was either a cistern or a dug well in the SW/SE/NE Section 1 T25N R6E. Little Chief Creek is seventy yards to the northwest but is not connected to the well. The 12.5 foot deep well is on a high point some forty feet above the creek.

Pony Creek Shale

The Pony Creek shale of Pennsylvanian age supplied water to only one abandoned well in the review area. That well had been a windmill in the NE/NE/NE Section 1 T25N R6E. Little Chief Creek is about one quarter mile to the west of the well.

Quaternary Alluvium

Some eight abandoned water wells in the review area receive water from Quaternary alluvium. These wells are very close to creeks, ponds or other surface water features. Several are at the water's edge of the pond or creek. One well is seventeen feet north of an old cesspool.

SURFACE DRAINAGE RELATIONSHIPS TO GROUND WATER

The four main creeks draining the NBU and SBU receive water from multiple formations and overland flow. The major stream which drains the entire area is Salt Creek. This stream crosses NBU about the middle of the unit. It receives water from Hay Creek which drains the upper third of NBU. The confluence is shortly before Salt Creek crosses the west NBU boundary. One of the older residents said the water in the streams was formerly salty due to the old practice of dumping produced water in the ditches. Lost Man Creek drains the remainder of the south end of NBU. Little Chief Creek drains all but one quarter section of SBU. Each of these creeks discharge or receive water from the formations they cross.

A close examination of the drainage pattern shows the main streams in the west side of the valley floor. This is a result of the westward dip. Note also that numerous tributaries to the bigger creeks rise from the cap rocks on the valley walls and run in almost a straight line to the tributary. Examination of several of these during the reconnaissance showed the rivulets to originate from a small spring or seep in the fractured cap rock. It is apparent that these rivulets are also fracture controlled in their origin. The fractures act as a collection and transmission system for the spring. Because of the dip the spring runs until the fractured unit is drained of free water. Thus the ground water above the flow line of a stream is quite transient and not reliable for a water supply.

The ponds in the area are located in the shale outcrop areas. Such a location would be prudent in order to hold any water collected and for easier construction. Phillips Lake was constructed primarily in the shale parting between the Hughes Creek and Americus Limestones. When the fracture pattern is considered in relation to Phillips lake and the inactive or abandoned water wells numbered 25 through 33, it is possible that the limestones are recharged by Phillips Lake. Water would flow through the fractures and be intercepted by the wells.

As explained earlier in the section on Fracture Hydrology, there is a moderate degree of interconnection between the streams and the fractured rock units. In a gaining section of a stream the fractures are discharging water into the stream. In a losing section of a stream the fractures are being recharged by the stream. Also, the fractures serve as storage for the stream; during high water periods water is stored in the fractures. Then, during dryer, low water periods the water stored in the fractures is released to the stream. This mechanism is similar to that of bank storage in alluvial stream banks, but in the fractured case, the fractures fill and empty much faster and do not provide as much storage.

DISCUSSION OF CONCLUSIONS

UNDERGROUND WATER SOURCES

The fractured rocks do act as aquifers, containing fresh waters. However, those waters are essentially unused. The waters were used by residents in the past but were of transient nature. Older residents stated that most people used cisterns and collected rain water. As early as 1927, Phillips was suppling water throughout the area. Portions of this system are still in use as the Shidler municipal supply. A rural water system has also been serving the area since 1972. Therefore, alternate reliable supplies are more readily available than drilling a well.

The water users in the area have switched to the more reliable water supplies demonstrating a bias against using ground water for human consumption. It is unlikely that these water users will return to ground water use in the reasonably foreseeable future. In fact, Shidler Lake is shown on many maps as authorized for construction to the east of the city of Shidler. Such a lake would be another alternate water supply for the area and users to the south. Kaw Lake to the west apparently has experienced fluctuating Total Dissolved Solids concentrations ranging from 400 to 1100 ppm.

Other evidence supporting the conclusions of a lack of usable ground water include the lack of windmills in the area and the many stock ponds. Windmills must tap a reliable water supply aquifer to be ready to pump water whenever there is sufficient wind. The stock ponds are a method of retaining surface runoff to water livestock. A stock pond is more expensive to construct and maintain than a windmill and stock tank.

Development of a ground water supply for a family or livestock would probably require several test wells, a large diameter well for collection and storage, treatment, pumps, and monitoring for contamination on a regular basis. The cost of connection to the rural water system including the necessary piping would be more economically feasible. The users who are not on the rural water system simply did not join because their needs were being met by a supply already in place.

The two ground water users in the area upgradient of the unit are using shallow ground water which is potentially subject to pollution from agricultural activities. One of the two Simmons wells were contaminated by nitrate fertilizer. Mr. Simmons who uses two wells to supply his water needs, reported that he had had nitrate contamination in his well close to the house. The contamination was apparently due to fertilizer in the garden near the well. Mr. Vogel whose well is used by two families reported that the pump in use would not pump the well dry. This well is ten feet square and twenty-one feet deep and is actually like a developed spring. It discharges water to the surface drainage almost continuously. The storage volume of the well is 15,750 gallons, so it is unlikely that two families would ever stress this well. The Vogel well or developed spring has agricultural activities to the northeast in the catchment area above the well. The total number of people served by these wells is less than 10.

A new well in the upper water producing zones would be subject to the same conditions which now occur in the area. In the reconnaissance the residents who used water from the upper zones were interviewed. Mr. Hanning, who uses rural water, reported that his water well would pump dry in thirty minutes with the small jet pump on the well. The well would refill over a few hours. Vogel and Simmons both reported that attempts to find water by nearby neighbors or relatives were not successful. Those persons are now served by the rural water district or have moved away. These events illustrate the spotty occurrence of ground water. Even if a well were successful the prudent resident would have to be constantly on guard against pollution of his supply.

Older residents descriptions of water wells contamination incidents indicate that the process was sudden. Several older gentlemen stated that wells which had been producing good water would produce salt water the following day. It was typical for many people to haul water from a good well in the area. Their descriptions of the water production and contamination of these wells fit that of a fractured aquifer. Simmons description of his nitrate contamination further illustrates that whatever shallow ground water might exist may be easily contaminated from surface activity.

Pat Donham, retired, was the geologist in charge of a corehole drilling program for a massive structural study of Osage County. He reported that many of the core holes drilled did not encounter fresh water but did hit salt water. In particular, he recalled that holes drilled for water wells at the Adams ranch and coreholes drilled on the Murphy ranch only encountered salt water at shallow depth, i.e.; less than 500 feet. He attributed this to salt water rising in the formations during drought conditions as the fresh water is removed. It is well known that these marine origin formations which outcrop in the Shidler-Burbank area contain salt water to the west as the rock layers dip lower beneath younger sediments.

In the following section on the geology of the area, the thin, layered stratigraphy is described. The intervening shales between the limestones and sands typically have low permeabilitys which effectively hydraulically isolate the beds from one another. Although no tests have been performed on the beds of the upper section, it can be reasonably assumed that the characteristics of these beds would be similar to those described in texts and other literature. The swelling characteristics of the clay minerals in the shales would tend to close the open holes around the casing. Especially in the presence of fresh water, this swelled clay would effectively seal the zones from one another. Such a seal provides a low degree of interconnection between any aquifers.

Cable tool driller's logs (vintage 1920-1943) were selected and reviewed to determine what evidence they might provide concerning formation waters. The logs were selected by the well's proximity to the line of cross section to provide coverage from the northwest corner of NBU to the south end of SBU. A suprising amount of detail was kept in the logs and correlates well with the cross section. Table III is a compendium of that review and shows the water occurances. Table IV shows the casing program used in the wells. The zones where the driller's log indicates water are described giving the depth, rock type, thickness, and quantity of water produced. Those occurrances are frequently correlatable between closely spaced wells and seem to be emanating from the same aquifer. The quantity estimates are subjective because the size of bailer is unknown and the rate of bailing is often unknown. Also, some of the terms such as, Hole Full of Water, are not defined. Thus, it is unknown if there is a rate of flow involved or if the water rose to the surface. It is reasonable to assume that such terms indicated that the driller had to bail off or handle the water in some way. In cable tool drilling, a driller sets casing to block water entering the hole.

The cable tool driller sets intermediate casing strings for several reasons. First, surface casing is set to keep the upper part of the hole stable. Second, the intermediate casing strings are set to hold the hole open or to keep out water. In keeping the hole open, the driller must contend with swelling shales, flowing sands, or other caving formations. If water fills the hole then the effectiveness of the percussion action is greatly reduced. Normally the driller must add some water to the hole to create a slurry so the bailer can pick up the cuttings. If water production of the zones above the cutting face of the bit is slow enough then the normal bailing cycle will keep up with the water production. Excess water can be bailed off or an intermediate string of casing set to prevent water entering the hole.

Once an intermediate casing is set, drilling continues with a bit which will fit inside the intermediate casing. When conditions down hole include excess water or other problems, another intermediate string of casing is set and the previous casing is pulled and used at another well. Table IV shows a remarkable consistencency in the depths where the drillers set the surface casing. That the first intermediate casing was not set until about the 800 foot depth indicates that the formations encountered were thin, relatively competent, and contained very little water. On some logs the drillers comment that the water for cutting removal got away through a crack. Due to the lack of comments, it can be reasonably assumed that the drillers did not encounter sufficient water to create a problem higher in the hole.

"Z SAND" WATER

The "Z Sand" is a deltaic/fluvial sand of nearshore (brackish water) marine origin which is hydraulically contiguous spatially. The unit contains waters to the northwest and probably also to the west which contain greater than 10,000 ppm Total Dissolved Solids. Attempting to produce water from the unit would relieve the fresh water head holding the salt water lower in the section. The loss of the retaining head would allow the salt water to migrate into the less contaminated zones.

Production of water from the "Z Sand" is not economically justifed when the ready availability of other supplies is considered. The costs of drilling 600 to 700 ft, pumping, treating, and distribution from a zone that contains water unfit for human consumption are beyond the $700.00 cost of a rural water connection and $25.00 monthly bill.

DEEPER ZONES

The cross sections derived from electric logs were submitted to the US EPA earlier. It is understood that it was agreed that the units below the "Z Sand" and most of the "Z Sand" were considered to contain water with greater than 10,000 ppm Total Dissolved Solids content. This conclusion was reached through evaluation of the Self Potential and Resistivity logs.

GEOLOGY OF GREATER BURBANK AREA

AREA OF STUDY

The area of this study - Greater Burbank Area - includes Townships 25, 26, and 27 north and Ranges 6 and the east half of 5, comprising 162 square miles. North and South Burbank Units are located near the center of the mapped area.

The objective of the geologic investigation is to examine the shallow stratigraphic units, and to show the relationship of these rocks to the occurrence and character of shallow ground water.

STRATIGRAPHY

REGIONAL

Pennsylvanian Series - Virgilian

Northern Oklahoma, including the Burbank area, was a broad essentially flat coastal plain - excepting the long, narrow NNE trending range of mountains called the Nemaha Ridge which extends from northeast Kansas to central Oklahoma. Repeated fluctuations in sea level in response to glaciation elsewhere in the world, alternately flooded and retreated from the coastal plain, laying down repetitious shallow marine beds of shale, limestone, coal and sandstone in cyclic fashion. The broad flat coastal plain caused these cyclic rocks to be deposited in very widespread, consistent layers, continuous in both thickness and lithology. This is particularly evident in the Burbank area as illustrated by the "layer cake" stratigraphy in the Cross Section, Enclosure 2.

Permian Series - Wolfcampian

An unconformity separates the Wolfcamp from the Virgil sediments. The boundary is usually considered to be at the first depositional break above the Brownville limestone. However, the Brownville as mapped in the Burbank area is actually the Five Point limestone of Kansas where both units were named; and the Brownville of Kansas is equivalent to the Grayhorse limestone in the Burbank area. Thus the Brownville as shown in the southeast corner of the Location Map, Enclosure 1, and the Areal Geologic Map, Enclosure 8, may be drawn 30 to 40 feet too high.

Early Permian sediments in the Burbank area are very similar in lithology and extent to those of the late Pennsylvanian, i.e. alternating limestone, shales, and sandstones with occasional thin coals with limestones predominating. The Neva and Foraker Limestones are the two most important intervals and are key markers in the Greater Burbank area. Both limestones are extensively fractured as shown on the Location Map, Enclosure 1. Consistency of the lithology and thickness of these sediments is again evident as shown in the Cross Section, Enclosure 2. For the most part, these sediments were named and described in central Kansas and are continuous and recognizable into northern Oklahoma. Considerable fluctuations in sea level at fairly short intervals resulted in deposition of thin beds of shale, limestone, and sandstone in cyclical fashion. Sediments of fluvial/deltaic origin are evidenced by occasional channel sands which have very short lateral extent and exhibit rapid facies changes.

Following early Permian (Wolfcampian) time, the Mid-Continent area was tilted to the west producing the very subtle Prairie Plains Homocline which is coincident with the west flank of the Ozark uplift.

STRUCTURE

The Burbank area is located in the Cherokee Basin, on the southwest flank of the Chautauqua Arch, and east of the southern extension of the Nemaha Ridge. About ten miles to the east is the Oklahoma en echelon fault zone. Regional strike of bedding is slightly east of north (N 8 to 15 degs. E) as graphically shown on the Structure Contour Map, (Enclosure 3), and by the outcrop pattern of the wide, NNE-SSW trending bands on the Areal Geology Map, Enclosure 8. Regional dip is extremely low, averaging 30 to 50 feet per mile to the west but is interrupted occasionally by local reversals in dip having up to 20 feet of closure, such as Hay Creek anticline, Section 6, T26N, R6E. Because there is no major angular unconformity between the surface beds and the base of the Pennsylvanian, the structure expressed by the surface rocks reflects the structure of the underlying Pennsylvanian sediments, with the exception of faulting.

FAULTS

No faults were observed in the surface rocks, but there is evidence of faulting in the subsurface at the depth of the Pennsylvanian sediments. It is believed that NW trending minor faults (10 to 20 feet displacement) similar to those which are so prevalent just ten miles to the east, are also present in the Burbank area but are concealed beneath the blanket of Permian sediments. These faults are aligned in NE trending belts or zones collectively called the Oklahoma En Echelon Fault Zone and are believed to be extension features caused by left lateral movement along major N 15 deg E trending wrench faults in the Precambrian basement. Such buried extension faults may be expressed on the surface in the Burbank area by distinct zones of NW trending fractures as shown at several localities on the Location and Areal Geologic maps.

FRACTURES

An extremely consistent orthogonal fracture system is expressed by the surface rocks of the Burbank area and is ubiquitous in northeastern Oklahoma and southeastern Kansas. The primary fracture set has a mean orientation of N 70 degs E and comprises nearly 90% of the mapped fractures shown on the Areal Geologic map. A secondary fracture set is oriented at right angles (N 25 degs E). This relationship is shown graphically on the rose histogram in the explanation column of Enclosure 1. This fracture system is documented in the subsurface at the depth (3000 ft) of the Burbank sandstone from well data, and is believed to be related to the stresses which acted upon the stable platform comprising NE Oklahoma and SE Kansas. The key to the geology of NE Oklahoma including the Burbank area appears to be the geologic consistency of the area. That is to say, the stratigraphy is very consistent, lithologies are uniquely widespread and uniform in thickness. Structure is consistently low dipping, NNE striking, and essentially uncomplicated. Hence, fracturing is orthogonal and has a consistent trend over the entire region averaging N 70 deg E and N 25 deg W.

CROSS SECTION

A stratigraphic cross section, Enclosure 2, which includes the shallow subsurface and exposed sedimentary rocks was constructed along a line which closely parallels the subsurface cross section C-C', constructed from Burbank Field electric well logs, (submitted earlier). The shallow section trends roughly N 20 degs W through the center of the North and South Burbank Units. The scale of the section is 1 inch equal 20 feet for the vertical and 1 inch equal 2640 feet for the horizontal, providing a vertical exaggeration of 132 to 1. This greatly exaggerated vertical scale was selected in order to show the details of the stratigraphic units including the lithologies, their thicknesses, and permitting accurate correlation of the very thin beds from NW to SE through the greater Burbank area.

The section was constructed using stratigraphic data from four sources. At the NW end, control is provided by electric log data from Core Hole 10, located in Section 34, T29N, R5E, six miles north of the north end of the cross section. At the SE end, control is taken from Core Hole 22, (Section 35, T25N, R5E) located seven miles west of the south end of the section. Because this log contains a more complete interval of rocks, Core Hole 22 log data has been "extrapolated" from the west into its proper position with respect to sea level datum in the cross section. All of the units above the Americus limestone are missing by erosion at the true SE end of the cross section. To illustrate this on the cross section, everything above the exaggerated topographic profile is depicted by faint dashed lines. The section was constructed in this fashion to demonstrate that the thicknesses of these rock units are quite consistent. Data for the middle portion of the cross section have been taken from M.S. thesis work by D. L. Vosburg. The measured section by Vosburg was composited from field measured intervals scattered throughout the Greater Burbank area. Field measured thicknesses and lithologic descriptions by Vosburg are very consistent with those picked on the Core Hole electric logs. Finally, bed thicknesses along the line of cross section were checked using elevation data from the proprietary photogrammetric mapping study "The Structure of Osage County, Oklahoma" completed by Phillips Petroleum Co., Exploration Projects Section in 1957. Only minor thickness variations were noted, and these are often exceeded by the margin for error inherent to the technique.

As shown by the cross section, the thickness of the units is notably consistent in the Burbank area as indicated by the parallelism of the the formation and member boundaries. The total thickness of the section between the top of the Pennsylvanian Reading limestone and the top of the Permian Neva limestone is 472 feet at Core Hole 10, and the same interval is 509 feet thick at Core Hole 22 located 24 miles to the south. The net difference in thickness is only 37 feet over this distance. The greatest thickness change occurs in the Permian section as shown in the comparison table below.

AGE	INTERVAL	CORE HOLE 10	CORE HOLE 22	NET CHANGE
Permian	Top Neva ls. Top Brownville ls.	221'	265'	44'
Pennsyl.	Top Brownville ls Top Reading ls.	251'	244'	-7
		472'	509'	37'

The Pennsylvanian interval (Brownville to Reading) thickens by only 7 feet toward the north and the Permian interval (Neva to Brownville) thickens by 44 feet to the south. The net change toward the south is only 37 feet. Intervals which thicken and/or thin do so at the expense of the units above or below, so that the net change is negligible.

Because the cross section is based on a sea level datum, it illustrates regional dip of the Prairie Plains Homocline toward the west-northwest. Although the dip is extremely low, (30 to 40 ft /mile), due to the extreme vertical exaggeration (132 to 1) of the cross section dip appears to be quite steep. Furthermore, since the line of section is partly along strike, the rate of apparent dip along the strike section is only about 12 feet per mile.

TOPOGRAPHY

The exaggerated topographic profile which is superimposed on the section has been added to illustrate approximate topography along the line of section and to show the position of the rock units with relation to the topography. A more realistic topographic profile, with a vertical exaggeration of only 10 to 1, is drawn along the top of the cross section for comparison.

Lithology is the controlling factor in the development of Burbank area topography. The alternating layers of limestone and shale have formed a series of subtle east-facing escarpments separated by west-facing grass covered slopes. The more resistant limestones cap the hills and cuestas, while the shales form rolling hills or occupy valley floors. The escarpments are formed by the thicker limestone units, namely the Foraker Limestone in the east, the Neva limestone over the central portion of the mapped area and the Crouse and Cottonwood limestones in the west. Long shale slopes are formed by the Hamlin, Johnson, Roca, Eskridge and Easly Creek shales. The shale slopes, benches and ledges are mostly treeless. Salt Creek is the major drainage of the Burbank area. It and Little Chief Creek carry water most of the time. Little Chief Creek is a tributary of Salt Creek which flows generally southwest to its confluence with the Arkansas River. All other streams are intermittent.

Though controlled by the dip and fractures, creek valleys are broad and meandering, occasionally very flat, alluvium filled, and occasionally deeply incised into the underlying rock outcrops. The very flat areas are frequently cultivated and elsewhere are tree covered. Salt Creek is contained by 200 foot high cliffs controlled by Foraker Limestone at its confluence with Little Chief Creek. The overall drainage pattern is dendritic, and has been shown to be controlled in large part by the fracture system in the surface rocks. That is to say that the lower order tributaries flow in solution widened fractures in the limestones.

Topographic elevations of the area range from 1250 feet in the east central part of the area to a low of 820 feet in the Salt Creek bottom near the southwest corner of the map area. The gentle topographic relief reflects the low regional westward dip.

The long, gentle, western slopes of the cuestas are often covered by the shale units which retard surface water from entering the fractured limestones. Only on the margins of the cuestas are the soil mantles thin enough to allow the fractures to capture much of the rainwater impinging on the surface. The short, steep, eastern slopes which are typically protected by a limestone caprock allow surface water to runoff quickly without sufficient time to enter the exposed formations. Thus, there are topographic limitations to the total quantity of recharge available to the ground water in the area.

TABLE I: BURBANK UNIT AREA WATER SOURCES

NUMBER OF WATER SOURCES AND ASSOCIATED FORMATIONS

NO.	MEMBER UNIT NAME	FORMATION NAME	AGE
1	COTTONWOOD LIMESTONE	BEATTIE LIMESTONE	PERMIAN
6	ESKRIDGE SHALE		PERMIAN
10	NEVA LIMESTONE	GRENOLA LIMESTONE	PERMIAN
8	BENNETT LIMESTONE	RED EAGLE LIMESTONE	PERMIAN
2	JOHNSON SHALE		PERMIAN
10	LONG CREEK LIMESTONE	FORAKER LIMESTONE	PERMIAN
8	HUGHES CREEK LIMESTONE	FORAKER LIMESTONE	PERMIAN
2	AMERICUS LIMESTONE	FORAKER LIMESTONE	PERMIAN
1	BROWNVILLE LIMESTONE		PENNSYLVANIAN
1	PONY CREEK SHALE		PENNSYLVANIAN
8	QUATERNARY ALLUVIUM		QUATERNARY
5	MULTIPLE FORMATIONS		
3	CISTERNS (EXISTING)		
1	WELL IN POND DIKE		
8	UNDETERMINED		
74	TOTAL WATER SOURCES		

NOTE: Some dug wells may be cisterns.
The Eskridge, Johnson, Brownville, and Pony Creek members are not associated with a formation.
Water from the Eskridge is from a thin limestone.
Water from the Johnson is from sand lenses.
Water from the Pony Creek is from a sand layer.

TABLE II: DETAILED LISTING BURBANK UNIT AREA WATER SOURCES FIELD RECONNAISSENCE - JAN-FEB 1987
INCLUDES WELLS, SPRINGS, CISTERNS, LAKES, AND STREAMS (PONDS EXCLUDED) M.S. BRANNAN

WELL NO.	OWNER	LEGAL LOCATION QTR(S)	SEC/TP/RG	WELL DESCRIPTION METHOD	DEPTH	DIA.	CASING	WATER FORM.	EPA LIST	USEABLE (Y/N) (CONDITION)	GENERAL REMARKS
1		SW/SE/NW	1 25 6	DUG	12.5	72	BRICK	BV LS	NO	NO, CISTERN	CREEK 70 YDS NW
2		SW/SE/SE	2 25 6	DUG	6			Q ALV	NO	NO	CREEK WITHIN 10 FT
3	HANNING	SW/SW/SE	5 27 6	DUG	4.7	66	BRICK	ES SH	Y(1)	NO, CISTERN	HAZARD TO STOCK
4		SE/SW/SW	5 27 6	?	?			?		NO	TORNDOWN WINDMILL
5	HANNING	SW/NW/NW	8 27 6	DRILLED	49	6	GALV.	NV LS	Y(2)	YES, ON RWD	PUMP DRY IN 30 MIN.
6	HANNING	SW/NW/NW	8 27 6	DRILLED	49	6	GALV.	NV LS	Y(2)	YES, ON RWD	HAND PUMP 10 FT E OF #5
7	VOGEL	NW/SW/SW	8 27 6	DUG	21	120	STONE	ES SH	Y(3)	YES, 2 FAMILY	DEVELOPED SPRING
8		SW/SE/SW	13 27 5	UNK	UNK	26	UNK	CW LS	Y(4)?	NO, FILLED	NBU 33-2 50YDS SW
9		NW/NW/NW	23 27 5	DRILLED				?	NO	NO	LARGE ROCK ON OPENING
10		NW/NE/NW	23 27 5	DUG	UNK	36	CONC.	Q ALV	Y(5)	CESSPOOL 17'So	IN STREAM & MARSH
11	CLAPP	NW/NE/NW	30 26 6	DRILLED	62.5	6	GALV.	NV LS	Y(9)	YES, NO PUMP	NOT USED, ON RWD
12	CLAPP	NW/SW/NE	30 26 6	UNK	NA			Q ALV	NO	NO, PLUGGED	ON POND FRINGE
13	CLAPP	NW/SW/NE	30 26 6	DRILLED	8.5	7	STEEL	Q ALV	NO	NO, PLUGGED?	WEST OF 12 180'
14	BURBANK	SE/SW/SW	25 26 5	DUG	27	144	ROCK	LC LS	Y(10)	YES, CITY WELL	SALT CREEK 200' EAST
15	SWINSON	SW/SW	25 26 5	DUG	30			LC LS	Y(11)	YES, IRRIGATION	SALT CREEK TO EAST
16	DOYAL	SW/SW	25 26 5	DUG	30			LC LS	Y(12)	YES, IRRIGATION	SALT CREEK TO EAST
17	BURNSIDE	SW/SW	25 26 5	DRILLED	32			LC LS	Y(13)	YES, IRRIGATION	SALT CREEK TO EAST
18	CLIPPER	SW/SW	25 26 5	DUG	30			LC LS	Y(14)	YES, NOT USED	SALT CREEK TO EAST
19	SMITHDEW	SW/SW	25 26 5	DRILLED	42			LC LS	Y(15)	YES, HOUSE/IRR	SALT CREEK TO EAST
20	BURBANK	SEorSW	31 26 6	LAKE	35		QUARRY	BT LS	Y(20)	YES, CITY STBY	OLD LIMESTONE QUARRY
21	BELLMARD	NW/NE/SW	25 26 5	DUG	NA	48	ROCK	LC LS	NO	NO, BIO. CONT.	SALT CREEK TO WEST
22	BELLMARD	NE/NE/SW	25 26 5	DUG	10.8	72	ROCK	BT LS	NO	NO, ADJ. WELL	POND 150' NE
23	BELLMARD	NE/NE/SW	25 26 5	DUG	12	36	CMP	BT LS	NO	YES, HOUSE	HOUSE 600' WEST
24		SE/SW/SE	7 25 6	UNK	NA			?	NO	UNK	LOST MAN CREEK BANK
25	BOWEN	NE/SW/SE	18 26 6	UNK	NA	NA	NA	?	NO	NO, FILLED	OLD WELL UNDER SHOP
26	BOWEN	NE/SW/SE	18 26 6	UNK	NA	NA	NA	?	NO	NO, DRY HOLE	SOUTH OF HOUSE
27	BOWEN	SE	18 26 6	DRILLED	70	3	NA	HC LS	NO	YES, NOT USED	POOR PRODUCER, (HOGS)
28	BOWEN	SE	18 26 6	DRILLED	60	NA	NA	HC LS	NO	NO, HARD & FE	NEAR POND ON RWD
29	BOWEN	SE	18 26 6	UNK	20	NA	NA	JO SH	NO	YES, NOT USED	NEAR POND
30	BOWEN	SE	18 26 6	DRILLED	30	NA	NA	JO SH	NO	YES, NOT USED	WELL IN SPRING, (HOGS)
31	CHEVRON	NE/NE/SE	18 26 6	DRILLED	NA	4	GALV.	?	NO	YES, NOT USED	POND 100' SE
32	CHEVRON	NE/NE/SE	18 26 6	DRILLED	55	13	STEEL	HC LS	NO	YES, NOT USED	CREEK 60' NORTH
33	JACQUES	SE/SE/NE	18 26 6	DRILLED	29	8	STEEL	LC LS	NO	YES, ON RWD	CREEK 60' SOUTH
34	JACQUES	SW/SW/NW	8 26 6	DUG	2	30	ROCK	LC LS	NO	NO, FILLED	SALT CREEK 600' SW
35	JACQUES	SW/NW/SW	8 26 6	DUG			ROCK	HC LS	NO	NO, DOZED IN	SALT CREEK TO SW
36	JACQUES	SW/NW/SW	8 26 6	DUG			ROCK	HC LS	NO	NO, DOZED IN	SALT CREEK TO SW
37	JACQUES	SW/SE/NW	6 26 6	DRILLED	NA	4	GALV	?	NO	NO, FILLED	HAY CREEK 300' E&So
38		SE/NW/SW	5 26 6	DRILLED	29	6	STEEL	BT LS	NO	YES, ABANDONED	NBU 104-14 600' SE
39		SE/SW/NW	5 26 6	SPRING				BT LS	NO	NOT DEVELOPED	LS OUTCROP 300'E NBU96W1

TABLE II: DETAILED LISTING BURBANK UNIT AREA WATER SOURCES — FIELD RECONNAISSENCE - JAN-FEB 1987
INCLUDES WELLS, SPRINGS, CISTERNS, LAKES, AND STREAMS (PONDS EXCLUDED) — M.S. BRANNAN

WELL NO.	OWNER	LEGAL LOCATION QTR(S)	SEC/TP/RG	WELL DESCRIPTION METHOD	DEPTH	DIA.	CASING	WATER FORM.	EPA LIST	USEABLE (Y/N) (CONDITION)	GENERAL REMARKS
40	JACQUES	SW	12 26 5	DUG				Q ALV	NO	NO, ABANDONED	REPORTED BY JACQUES
41		NW	13 25 5					Q ALV	NO	?, HAND PUMP	MUD ACCESS
42		NW/NE/SW	13 26 5	SPRING				BT LS	NO	YES, STOCK	IN BARN (10GPM)
43		NW/NE/SW	13 26 5	DRILLED	65	4	GALV.	LC LS	NO	YES, NOT USED	SW OF BARN W/SPRING
44		SE/SW/NW	10 26 6	DUG		48	ROCK	BT LS	NO	NO, FILLED	PHILLIPS LAKE TO EAST
45		SW/SE/SW	4 26 6	SPRING		72	CONC.	HC LS	NO	NO, FILLED	PRODUCING SMALL FLOW
46	HANNING	SE/SW/SE	27 27 5	DUG	2	36	ROCK	QA-ES	NO	NO, FILLED	NEAR MUD CREEK
47		NE/NE/NE	35 27 5	DUG	17.2	144	BRICK	NONE	NO	NO, CISTERN	FILTER BOX TO EAST
48	B. BERTHA	NW/SE/SE	35 27 5	DUG	17	120	BRICK	NONE	NO	NO, CISTERN	ON EAST SIDE OF ROAD
49	B. BERTHA	NE/SW/SE	35 27 5	DUG	18			NONE	Y(6)	NO, CISTERN	ON WEST SIDE OF ROAD
50	RUSSELL	SE/NW/NW	36 27 5	DUG ?	?	16	STEEL	P DAM	NO	YES, NOT USED	DIKE COM. TO 3 PONDS
51		SE/SW/SE	4 26 6	DUG	18.5	40	ROCK	HC LS	Y(8)	NO, JUNK	SALT CREEK 300' So.
52		SW/SE/SE	4 26 6	DUG	20	NA	UNK	HC LS	NO	NO, NOT USED	NO PUMP ON WELL
53	PONTIUS	NE/SW/SE	33 27 6	DRILLED	28 ?		UNK	BT LS	Y(7)	YES, LIVESTOCK	POND TO WEST 4'SQ CISTERN
54	R. ROSS	SW/SE/NE	18 27 6	DRILLED	48	6	STEEL	NV LS	NO	YES, NOT USED	HOUSE 80' WEST
55	R. ROSS	SE/SE/NW	18 27 6	DRILLED	50	6	STEEL	NV LS	NO	YES, NOT USED	NBU 27-1 300' ESE
56	R. ROSS	SW/SW/NE	18 27 6	DUG	8.5	96	ROCK	ES SH	NO	YES, NOT USED	POND 100' WEST, CREEK
57		SE/SE/SE	7 27 6	DUG	?	?	UNK	?	NO	NO, COLLAPSED	NBU 20-4 300' EAST
58		NE/NE/NW	18 27 6	DRILLED	65	5	GALV.	NV LS	NO	YES, NOT USED	WATER LEVEL 27.2'
59	SIMMONS	NE/NW/NW	7 27 6	DRILLED	50			ES SH	NO	YES, IN USE	WELL DEPTH 35' TO 50'
60	SIMMONS	NE/NW/NW	7 27 6	DRILLED	50			ES SH	NO	YES, IN USE	WELL DEPTH 35' TO 50'
61	SIMMONS	SW/SE/SW	6 27 6	DRILLED	100	0	NONE	NV LS	NO	NO, NEVER USED	NO WATER FOUND, SIMMONS
62		SE/SW/SE	1 27 5	DUG	26	108	ROCK	ES SH	NO	YES, NOT USED	WATER LEVEL 6' CREEK 60'E
63	BROWN	NE/NW/NW	11 27 5	DRILLED	85	7	STEEL	NV LS	NO	NO, STRONG ODR	WL 34.5' SULFUR ODOR
64	BROWN	NE/NW/NW	11 27 5	DRILLED	?	7	STEEL	NV LS	NO	NO, SEWAGE ODR	WELL 230' SE OF 63
65	WILKIN R	NE/SE	36 26 5	DRILLED	50			AM LS	Y(16)	NOT USED	STICKS UP 6' IN FIELD
66	WILKIN R	NE/SW/SE	36 26 5	DUG	33			AM LS	Y(17)	NOT USED	HAY CREEK TO SW
67		NE/NE/NE	1 25 6	DUG	6			Q ALV	Y(18)	NO	LITTLE CHIEF CREEK WEST
68		NE/NE/NE	1 25 6	DRILLED	72			PC SH	Y(19)	NO	ABANDONED WINDMILL
69		SW/NE/SE	24 27 5	DUG				NV LS	NO	NO, CISTERN ?	WEBB CITY SCHOOL
70	SHIDLER	CENTER	10 26 6	LAKE			DAM	MULTI	NO	YES, MUNICIPAL	ROCK CREEK & BT LS
71	HAY CK.	NORTH HALF NBU		STREAM				MULTI	NO	YES, LIVESTOCK	DRAINS ABT. 15 SQMI NBU
72	SALT CK.	CROSSES NBU		STREAM				MULTI	NO	YES, LIVESTOCK	MAIN DRAINAGE FOR NBU
73	LOST MAN	SOUTH NBU		STREAM				MULTI	NO	YES, LIVESTOCK	DRAINS ABT. 3 SQMI NBU
74	LTL.CHIEF	SOUTH BURBANK UNIT		STREAM				MULTI	NO	YES, LIVESTOCK	DRAINS MOST OF SBU 4 SQMI

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	DATE COMPLETE	FIRST WATER (0 TO 500 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW R.	SECOND WATER (500 TO 700 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW R.
1	1/1	6/1/26								
2	3/1	6/7/24								
3	3/6	6/7/24								
4	9/1		420	SAND (WATER)	10	4 B	800	RED ROCK SAND	5', 30'	7 B
5	9/2	9/15/24	208-507	BLUE SH.	299	3 B	780	SAND WATER	14'	WATER
6	15/3	6/2/24	390	WATER SAND	15	1 B/H	425	WATER SAND	15'	3 B/H
7	24/2	9/7/24	390	SAND	10	2 B/H				
8	24/3						780	SAND, WATER	10	4 B/H
9	32/1	5/21/24								
10	33/3	5/20/24					730	SDY LM	15	3 B
11	41/2	4/6/23								
12	41/14	1/14/24								
13	48/3	1/31/24	435	SHALE	40	WATER @475	690	LS HARD	10	WTR @690
14	48/5	2/2/24					715	SAND	5	1 B/H
15	49/9	5/18/23	640	SAND	5	4 B/H	850	SDY LM	30	HFW
16	49/10	6/5/23	630	SAND	5	4 B/H	640	SAND	30	10 B/H
17	50/5	11/4/22								
18	50/9	1/5/23								
19	50/15	2/1/23					805	SAND	25	HFW
20	51/2	10/23/22								
21	51/5	1/25/23								
22	51/11	12/15/22					725	SAND	30	12 B
23	52/9	11/17/22					720	SAND	15	4 B
24	53/11	11/20/22								
25	53/12	2/6/23								
26	54/9	4/30/23	435	SAND	10	WATER	770	SAND	10	WATER
27	54/16	10/11/23					670	BROKEN LIME	35	LITTLE WATER
28	54/13	7/14/23								
29	55/2	7/22/24					760	SAND	20	2.5 B/H
30	55/4	8/12/24					745	SAND	35	WATER
31	55/5	8/27/24					785	SAND	20	6 B
32	59/1	5/31/22					690	SAND	10	2 B/H
33	59/8	3/1/23	120	SAND	15	2 B/H	695	SAND	15	12 B
34	68/2	1/2/22					595	SAND	15	7 B

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED
NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.
ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	DATE COMPLETE	FIRST WATER (0 TO 500 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW R.	SECOND WATER (500 TO 700 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW R.
35	68/5	2/10/22					565	SAND	45	10 B
36	86/3	8/4/21					510	SAND	30	HFW
37	94/10	7/14/22	340	SAND	10	4 B/H	510	SAND	15	HFW 50 B/H
38	94/11	7/25/22	340	SAND	15	WATER	505	SAND	10	9 B/H
39	102/6	8/4/22								
40	110/8	4/1/23	535	SAND	35	HFW @560	925	SAND	35	HFW @930
41	111/9	8/28/22	538	SAND	12	WATER				
42	111/13	9/7/22	650	SDY LMST	10	1/2 B	735	SAND	32	HFW
43	112/5	4/4/22	540	SAND	9	HFW	555	SAND	10	HFW
44	113/1	9/8/20	490	SAND	20	WATER	520	SAND	5	WATER
45	114/2	4/21/21	350	SAND	10	1 1/2 B	460	SAND	25	HFW
46	117/6	9/3/23								
47	117/10	9/29/22	500	SAND	35	HFW	655	SDY LIME	25	5 B
48	127/6	4/8/24	20	LIME	105	6 B @40	655	SAND	35	HFW @655
49	127/7	3/22/24	575	SDY LIME	20	3 B @580				
50	129/2	3/7/25								
51	129/3	4/10/25								
52	129/4	11/19/26								
53	136/3	12/17/26					615	SAND	43	WATER
54	140/3	11/8/45								
55	140/4	11/27/45								
56	141	11/2/46								
57	E/1	NO DATE	375	SAND	25		515	SAND	15	
58	E/5	9/23/36					590	SAND	10	5 B@600
59	F/1	7/28/34	275	SAND	10	?	570	SAND	7	?
60	F/4	NO DATE					570	SAND	20	?
61	H/1	7/31/42	495	LIME SAND	5	1 B	547	SAND	43	HFW @547
62	J/2	NO DATE	446	SDY LIME	7	HFW				
63	J/12	12/1/35	450	SAND	10	?	520	SAND, SDY LM	50	?
64	K/10	NO DATE	460	SDY LM	30	?	560	SAND	40	?
65	O/1	NO DATE								
66	O/2	4/21/43								
67	S/6	6/25/36					550	SAND	20	?

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE,
SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED
NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.
ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	THIRD WATER (700 TO 900 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	FOURTH WATER (900 TO 1200 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	LINE NO.
1	1/1									1
2	3/1									2
3	3/6									3
4	9/1	870	SHALE RED ROCK	40', 5'	12 B	917	SAND	6	6 B	4
5	9/2	870	SAND	20	?					5
6	15/3	760	WATER SAND	10	8 B/H	870	WATER SAND	12	HFW	6
7	24/2									7
8	24/3	860	SAND, WATER	25	HFW	1073	SAND, WATER	10	4 B/H	8
9	32/1	840	SAND	20	HFW					9
10	33/3	820	SAND	15	20 BH					10
11	41/2					1020	SAND	15 ?	WATER ?	11
12	41/14	775, 815	SHALE, SAND	40, 20	HFW					12
13	48/3	860	SAND	30	15 B/H					13
14	48/5	830	SAND	12	HFW	1025	RED ROCK	38	9 B/H @1050	14
15	49/9	1085	SAND	40	HFW	1435	SAND	20	HFW @1440	15
16	49/10	805	SH., SAND	55, 30	HFW	1138	SAND	27	HFW @1142	16
17	50/5	820	SAND	20	HFW	1070	SAND	30	HFW	17
18	50/9					1000	SAND	45	WATER	18
19	50/15	1020	SAND	10	1 B	1050	SAND	55	HFW	19
20	51/2					1020	SAND	10	HFW	20
21	51/5	855	LIMST	25	WATER					21
22	51/11									22
23	52/9	795	SAND	15	4 B	985	SAND	25	HFW	23
24	53/11	820	?	15	HFW					24
25	53/12					1030	SHALE	50	HFW	25
26	54/9					1045	SAND	8	HFW	26
27	54/16	775	SAND	15	8 B/H	1034	SAND	24	LITTLE WATER	27
28	54/13	775	SAND	15	HFW	1040	SAND	20	HFW	28
29	55/2	790	SAND	10	15 B/H	1020	SAND	20	HFW	29
30	55/4	965	SAND	5	10 B	1030	SAND	30	HFW	30
31	55/5					1040	SAND	25	HFW	31
32	59/1	765	SAND	20	HFW					32
33	59/8	775	SAND	40	HFW	990	SAND	30	HFW	33
34	68/2	715	SAND	75	HFW					34

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE,
SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED

NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.
ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	THIRD WATER (700 TO 900 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	FOURTH WATER (900 TO 1200 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	LINE NO.
35	68/5	665	SAND	10	WATER					35
36	86/3					960	SAND	30	HFW	36
37	94/10	870	SAND	25	9 B/H	935	SAND	45	HFW	37
38	94/11	650	SAND	20	HFW	870	SAND	50	HFW	38
39	102/6	635	SAND	25	HFW	935	SAND	70	HFW	39
40	110/8	1300	SAND	6	HFW	1555	SAND	8	3 B	40
41	111/9									41
42	111/13	767	LIME	20	3 B	970	SAND	40	HFW	42
43	112/5	584	SHALE	17	HFW	700	SAND	15	HFW	43
44	113/1	835	SAND	15	WATER	855	SAND	15	WATER	44
45	114/2	787	SAND	35	HFW					45
46	117/6	745	SAND	25	HFW					46
47	117/10	870	RED ROCK	30	HFW					47
48	127/6					870	SHALE	10	HFW 770-780	48
49	127/7	720	SAND	41	HFW @720					49
50	129/2	670	LIME	110	HFW					50
51	129/3					770	SAND	25	HFW @775	51
52	129/4									52
53	136/3									53
54	140/3					720	SAND	20		54
55	140/4									55
56	141/1									56
57	E/1	590	SAND	30		818	SAND	17		57
58	E/5	660	SAND	45	HFW	935	SAND	5	HFW	58
59	F/1	640	SAND	35	?	885	SAND	25	WATER	59
60	F/4	640	SDY SH	20	?	875	SAND	40	?	60
61	H/1					835	SAND	25	HFW @850	61
62	J/2					765	SAND	70	HFW 765-785	62
63	J/12					770	SAND	15	HFW	63
64	K/10					770	SAND	22	?	64
65	O/1	685	SAND	24	HFW					65
66	O/2	640	SAND	30	WATER					66
67	S/6	620	SAND	45	HFW	782	SAND	13	?	67

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED

NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.

ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	FIFTH WATER (1200 TO 1500 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	SIXTH WATER (1500 TO 1800 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	LINE NO.
1	1/1					1055	SAND	40'	HFW	1
2	3/1					1100	SAND	65'	?	2
3	3/6	990	RED ROCK	80'	HFW	1070	WATER SAND	30'	HFW	3
4	9/1	1130	RED ROCK	40'	HFW	1430	SAND	15'	6 BLS.	4
5	9/2	1140	SAND	20'	HFW					5
6	15/3	1110	WATER SAND	50'	HFW	1185	WATER SAND	25'	HWW	6
7	24/2					1070	SAND	25	HFW	7
8	24/3	1103	WATER SAND	52	HFW	1325	SAND, WTR	25	3 B/H	8
9	32/1	1022	SAND	63	HFW	1255	SAND	25	HFW	9
10	33/3					1325	SAND	80	5 B/H	10
11	41/2									11
12	41/14									12
13	48/3	1115	SAND	25	HFW	1430	SAND	20	HFW	13
14	48/5	1076	SAND	19	HFW	1400	SAND	31	LITTLE WATER	14
15	49/9	1805	SAND	5	WATER	1850	SAND	30	WATER	15
16	49/10									16
17	50/5	1130	SAND	10	WATER					17
18	50/9	1115	SAND	!5	WATER	1350	SAND	5	WATER	18
19	50/15	1185	SAND	30	1 B	1395	SAND	20	HFW	19
20	51/2									20
21	51/5									21
22	51/11					1320	SAND	30	HFW	22
23	52/9	1045	SAND	30	WATER	1325	SAND	30	HFW	23
24	53/11									24
25	53/12					1340	SHALE	5	HFW	25
26	54/9	1060	SAND	11	WATER	1130	SAND	15	WATER	26
27	54/16					1315	SAND	25	HFW	27
28	54/13					1325	SAND	25	HFW	28
29	55/2	1065	SAND	25	WATER	1305	SAND	30	WATER	29
30	55/4	1100	SLATE	130	HFW	1485	SAND	15	WATER	30
31	55/5	1220	SAND	25	HFW					31
32	59/1									32
33	59/8	1035	SAND	30	WATER					33
34	68/2	1035	SAND	30	HFW	1180	SAND	20	WATER	34

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED

NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.

ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	FIFTH WATER (1200 TO 1500 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	SIXTH WATER (1500 TO 1800 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	LINE NO.
35	68/5	1065	SAND	30	WATER	1300	DK SLATE	40	HFW	35
36	86/3					1275	SAND	45	HFW	36
37	94/10					1240	SAND	35	HFW	37
38	94/11					1250	SAND	20	HFW	38
39	102/6									39
40	110/8	1650	SAND	30	1 B	1697	SAND	43	4 B	40
41	111/9					1660	SAND	10	WATER	41
42	111/13	1325	SAND	25	3 B	1690	SAND	20	9 B	42
43	112/5	940	SAND	55	HFW	1000	SAND	22	HFW	43
44	113/1	1065	SAND	10	WATER					44
45	114/2	1020	SAND	10	6 B/H	1050	SAND	15	HFW	45
46	117/6	975	SAND	70	HFW	1290	SAND	45	9 B	46
47	117/10	1175	SDY LIME	25	2 B	1240	SAND	40	HFW	47
48	127/6					1125	SAND	75	7 B @1135	48
49	127/7	945	SAND	30	HFW @960	1225	SAND	70	15 B @1270	49
50	129/2	985	RED ROCK	35	HFW	1370	SAND	20	HFW @1380	50
51	129/3					1015	SAND	70	HFW	51
52	129/4	980	SAND	20	WATER					52
53	136/3									53
54	140/3									54
55	140/4									55
56	141/1									56
57	E/1	942	SAND	10		1147	SAND	26	NO WATER REP	57
58	E/5	1115	SAND	25	HFW	1215	SAND	15	HFW	58
59	F/1									59
60	F/4	975	SAND	51	?	1190	SAND	23	?	60
61	H/1					1090	SAND	47	3 B/H	61
62	J/2	843	SAND	37	?	1040	SAND	25	HFW @1050	62
63	J/12	847	SAND	18	?	1045	SAND	29	?	63
64	K/10	838	SAND	48	?	1075	SAND	52	WATER	64
65	O/1	870	SAND	80	?	1075	SAND, SH.	37	?	65
66	O/2	853	SAND	37	WATER	1090	SAND	20	WATER	66
67	S/6	827	SAND	58	HFW	1065	SAND	30	HFW1070-1080	67

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED
NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.
ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	SEVENTH WATER (1800 TO 2100 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	EIGHTH WATER (> 2100 FT) DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	LINE NO.
1	1/1	1545	SAND	25'	5 B/H	1800	SAND	50'	HFW	1
2	3/1	1615	SDY LS.	45'	10 B/H	1800	SAND	?	HFW	2
3	3/6					1840	SAND	25'	HFW	3
4	9/1	1460	SAND	32'	6 BLS.	1605	SDY LM	40'	14 BLS.	4
5	9/2	1480	SAND W/CAVING	45'	HFW	1845	SDY LM & SH	25, 230	HFW	5
6	15/3	1225	WATER SAND	25'	HFW	1430	WATER SAND	25'	5 B/H	6
7	24/2					1835	BLUE SH	25, 175 ?	HFW	7
8	24/3	1420	SAND, WTR	25	7 B/H	1825	SAND	75	HFW	8
9	32/1					1850	SAND	30	HFW	9
10	33/3									10
11	41/2	1525	SLATE	?	WATER	1830	SAND	40	WATER	11
12	41/14	1395	SAND	20	HFW					12
13	48/3	1610	SDY SH	35	3 B/H	1820	SOFT SAND	50	HFW	13
14	48/5	1550	SAND	25	1/2 B/H	1610	SAND	5	HFW	14
15	49/9	2055	SAND	55	HFW	2270	SAND	15	WATER	15
16	49/10					1861	SAND	9	HFW @1865	16
17	50/5	2140	LIMST	15	4 B	2156	SAND	40	4 B MORE	17
18	50/9	1540	SAND	10	WATER					18
19	50/15	1545	SAND	15	3 B	1775	SAND	10	1 B	19
20	51/2									20
21	51/5	1510	LIMST	30	HFW	1818	SAND	75	WATER	21
22	51/11									22
23	52/9	1420	LIMST	30	3 B	1830	SAND	25	HFW	23
24	53/11					2090	SAND	60	HFW	24
25	53/12	1500, 1520	SAND, SHALE	15, 80	HFW					25
26	54/9	1490	SAND	10	9 B/H	1730	SAND	18	4 B/H	26
27	54/16	1370	SAND	15	HFW	1800	SAND	20	HFW	27
28	54/13	1475	SAND	15	WATER	2100	SDY LMST	75	5 B/H	28
29	55/2	1480	SAND	20	4 B/H	1780	SAND	20	8 B/H	29
30	55/4	1630	SAND	10	WATER	1730	SAND	20	WATER	30
31	55/5					2180	SAND	30	HFW	31
32	59/1	1720	SAND	15	HFW	2275	SAND	20	HFW	32
33	59/8	1510	SAND	15	12 B	1735	SAND	35	HFW	33
34	68/2	1490	SAND	50	WATER	1715	SAND	30	WATER	34

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED

NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.

ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE III: FORMATION WATER RECORDED IN DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	TRACT/ WELL	SEVENTH WATER (1800 TO 2100 FT)				EIGHTH WATER (> 2100 FT)				LINE NO.
		DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	DEPTH	ROCK TYPE	THICKNESS	FLOW RATE	
35	68/5					2080	SAND	110	BOILING	35
36	86/3					2035	SAND	35	WATER	36
37	94/10					1623	SAND	20	WATER	37
38	94/11					1640	SAND	20	4 B/H	38
39	102/6	1385	SAND	20	HFW					39
40	110/8	2033	SAND	32	4 B	2078	SAND	52	HFW @2094	40
41	111/9									41
42	111/13	2010	SAND	50	14 B	2060	SAND	120	HFW	42
43	112/5	1155	SAND	25	4 B	1250	RED ROCK	15	HFW	43
44	113/1	1935	SAND	90	WATER					44
45	114/2	1895	SAND	100	HFW					45
46	117/6	1585	SAND	10	HFW	2185	SAND	10	HFW	46
47	117/10	1640	SAND & LIME	125	4 B	2075	SAND	60	HFW	47
48	127/6									48
49	127/7	1665	SAND	10	2 B @1670					49
50	129/2	2105	SAND	95	6 B/H	2200	SHALE	10	HFW	50
51	129/3	1505	SAND	10	2 B @1510	2115	SAND	5	HFW	51
52	129/4	1340	SAND	15	WATER					52
53	136/3									53
54	140/3									54
55	140/4									55
56	141/1									56
57	E/1	1556	SAND	19	NO WATER REP	1945	SAND	45	NO WATER REP	57
58	E/5	1585	SAND	15	2 B	2030	SAND	35	HFW	58
59	F/1					1985	SAND	72	WATER	59
60	F/4					2000	SAND	40	?	60
61	H/1	1275	SAND	30	6 B/H	1890	SAND	65	HFW1890-1935	61
62	J/2	1205	SAND	20	HFW @1210	1855	SAND	45	HFW1855-1900	62
63	J/12	1210	SAND	5	?	1855	SAND	55, 20	?	63
64	K/10	1185	SAND	15	WATER	1885	SAND	80	WATER	64
65	O/1	1180	SAND	15	HFW @1190	1350	SAND	72	HFW @1350	65
66	O/2					2005	SAND	20	HFW	66
67	S/6	1160	SAND	5	HFW	1295	SAND	32	HFW	67

KEY: B=BAILERS OF WATER, B/H=BAILERS PER HOUR, HFW=HOLE FULL OF WATER, LM=LIME, LS=LIMESTONE, SDY=SANDY, SH=SHALE, SD=SAND, ?=SIMILAR ROCK REPORTED, WATER NOT MENTIONED
NOTE: WILLS IN NBU AR DESIGNATED BY NUMBER/NUMBER. SBU WELLS ARE ALPHA/NUMBER.
ALL REPORTS OF FORMATION WATER ARE LISTED. ON SOME LINES THIS CREATES AN INCONSISTENCY WITH THE HEADINGS.

TABLE IV: WELL CASING HISTORY FROM DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	SURFACE CASING DEPTH/DIA./LEFT	FIRST CASING DEPTH/DIA./LEFT	SECOND CASING DEPTH/DIA./LEFT	THIRD CASING DEPTH/DIA./LEFT	FOURTH CASING DEPTH/DIA./LEFT	FIFTH CASING DEPTH/DIA./LEFT	SIXTH CASING DEPTH/DIA./LEFT
1	36'/20"/	844'/15"/P	1144"/12"/P	1575'/10"/P	2259'/8"/	2755'/6"/	
2	40'/20"/	886'/15"/	1293/12/P	1514'/10"/P	2293'/8"/	2771'/6"/	2929'/5"
3	40'/20"/	877'/15"/P	1255'/12"/P	1597'/10"/P	2425'/8"/	2770'/6"/	2914'/5"
4	20'/20"/	920'/15"/P	1255'/12"/P	1499'/10"/P	2350'/8"/	2779'/6"/	2991'/5"
5	17'/20"/	892'/15"/P	1245'/12"/P	1492'/10"/P	2330'/8"/	2750'/6"/	2975'/5"
6	20/20/	882/15/P	1215/12/P	1365/10/P	2342/8/	2800/6/	2979/5
7	20/20/	887/15/	1277/12/P	1498/10/P	2317/8	2845/6	
8	25/20/P ?	895/15/P	1255/12/P	1478/10/P	2333/8/P	2800/6	
9	54/20/	868/15/P			2302/8	2968/6	
10	29/20/	843/15/P	1286/12/P	1771/10/P	2278/8	2793/6	
11		830/15/	1330/12/	1575/10/P	1900/8	2770/6	
12		833/15/P	1299/12/P	1550/10/P	1883/8	2755/6	2810/5
13	17/20/	906/15/P	1222/12/P	1545/10/P	2344/8/P	2827/6	3017/5
14	54/20/	853/15/P	1238/12/P	1485/10/P	2408/8/P	2826/6	2966/5
15	80/20/	815/15/P	1297/12/P	/10/P	2405/8/	2745/6	
16	45/20/	887/15/	1130/12/P	1481/10/P	2340/8/	2782/6	
17	36/20/	832/15/	1185/12/P	1857/10/P	2349/8/	2707/6	
18	20/20/	835/15/P	1302/12/P	1806/10/P	2388/8/	2740/6	
19	18/20/	837/15/	1147/12/P	1417/10/P	1865/8	2675/6	
20		820/15/P	1247/12/P	1755/10/P	2312/8	2740/6	2890/5
21		823/15/P	1235/12/P	1424/10/P	1875/8/	2743/6	2875/5
22		800/15/P	1250/12/P	1820/10/P	2220/8	2746/6	2885/5
23	18/20/	789/15/P	1217/12/P	1398/10/P	1864/8	2694/6	
24		840/15/P	1200/12/P	1735/10/P	2235/8	2725/6	2888/5
25		825/15/P	1260/12/P	1475/10/P	2230/8	2757/6	2880/5
26		785/15/P	1122/12/P	1514/10/P	2215/8	2757/6	2885/5
27	11/20	816/15/P	1346/12/P	1516/10/P	2345/8	2740/6	/5
28	24/20	794/15/P	1243/12/P	1673/10/P	2334/8	2760/6	
29		816/15/	1104/12/	1413/10/	2343/8	2761/6	/5
30	19/20	785/15/P	1100/12/P	1510/10/P	2315/8	2745/6	/5
31	15/20	807/15/P	1100/12/P	1752/10/P	2321/8	2735/6	/5
32		795/15/	1360/12/P	1810/10/P	2359/8	2690/6	
33		795/15/	1239/12/P	1808/10/	2351/8	2710/6	
34		790/15/	1105/12/	1383/10/	2213/8	2552/6	
35		765/15/P	1375/12/P	1760/10/P	2508/8	2708/6	

TABLE IV: WELL CASING HISTORY FROM DRILLER'S LOGS
NORTH AND SOUTH BURBANK UNITS

LINE NO.	SURFACE CASING DEPTH/DIA./LEFT	FIRST CASING DEPTH/DIA./LEFT	SECOND CASING DEPTH/DIA./LEFT	THIRD CASING DEPTH/DIA./LEFT	FOURTH CASING DEPTH/DIA./LEFT	FIFTH CASING DEPTH/DIA./LEFT	SIXTH CASING DEPTH/DIA./LEFT
36		740/15/P	1155/12/P	1733/10/P	2225/8	2676/6	
37	28/20	678/15/P	1153/12/P	1676/10/P	2215/8	2654/6	
38	17/20	695/12/P	1300/10/P		2123/8/	2658/6	2831/5
39	90/20	660/15/P	1277/12/P	1756/10/	2220/8/	2620/6	2787/5
40	10/20/	727/15/P	1065/12/P	1466/10/P	2285/8/	2650/6	2840/
41	35/20/	NONE	581/12/P	1033/10/P	2263/8	2654/6	2861/5
42	21/20	764/15/P	1200/12/P	1493/10/P	2283/8	2677/6	2884/5
43		729/15/	1062/12/	1437/10/	2286/8	2688/6	
44		678/15	961/12/	1621/10/	2547/8	2918/6	
45		654/15/P	961/12/P	1415/10/P	2200/8	2708/6	
46		780/15/P	1200/12/P	1447/10/P	2155/8	2710/6	2891/5
47	15/20	610/15/P	1165/12/P	1435/10/P	2255/8	2626/6	2829/5
48	36/20	748/15/P	1114/12/P	1346/10/P	2170/8	2719/6	2870/
49		767/15/P	1080/12/P	1473/10/P	2143/8	2702/6	2849/
50	20/20	831/15/P	1153/12/P	1610/10/P	2224/8	2783/6	/5
51	26/20	816/15/P	1143/12/P	1397/10/P	2217/8	2784/6	2914/5
52	19/20	807/15/P	1145/12/P	1577/10/P	2300/8	2764/6	/5
53	17/20	735/15/P	1079/12/P	1410/10/P	2249/8	2729/6	
54	115/10						2905/7
55	114/10						2920/7
56	139/10						2850/7
57	20/20	638/15/?	942/12/?	1116/10/?			2694/7
58	45/12	710/10	960/10	1145/10	2196/8	2685/8	2814/7
59						2673/7	2820/5
60							
61					2110/8	2583/6	2691/5
62	30/20	693/15/P	888/12/P	1100/10/P	2088/8		
63						2679/7	
64							
65							
66							
67							

ATTACHMENT IV
PRINTOUT OF
RESULTS OF TDS CALCULATIONS
FROM SP LOGS

WELL NO.	FRM NAME	Z-SAND
SBU C-6	DEPTH TOB FT	710
LOG DATE	THKNS FM FT	50
9-12-53	THKNS BED FT	20
LOG TYPE	SP, -MV	16
IEL	Tf, F	70
TD, FT	Rsn, OM	20
2928	Rm @ T, F	1.6
BHT, F	Rmf @ T, F	1.2
104	Rsn/Rm	12.5
Rm, OHM MTR	Corctn Fctr	1.03
1.32	SSP, -MV	16.9
@T, F	Rwe	0.68
86	Rw @ T, F	0.69
Rmf, OHM-MTR	Rw @ 75F	0.64
0.82	TDS	8676
@T, F		
104		

WELL NO.	FRM NAME	Z-SAND
SBU E-7	DEPTH TOB FT	665
LOG DATE	THKNS FM FT	55
12-6-58	THKNS BED FT	55
LOG TYPE	SP, -MV	25
EL	Tf, F	69
TD, FT	Rsn, OM	28
2865	Rm @ T, F	2.5
BHT, F	Rmf @ T, F	2.0
104	Rsn/Rm	11.3
Rm, OHM-MTR	Corctn Fctr	0.98
3.2	SSP, -MV	24.4
@T, F	Rwe	0.91
52	Rw @ T, F	1.02
Rmf, OHM-MTR	Rw @ 75F	0.95
1.4	TDS	5737
@T, F		
104		

WELL NO.	FRM NAME	Z-SAND
SBU E-8	DEPTH TOB FT	648
LOG DATE	THKNS FM FT	55
12-13-58	THKNS BED FT	55
LOG TYPE	SP, -MV	18
EL	Tf, F	69
TD, FT	Rsn, OM	28
2856	Rm @ T, F	2.6
BHT, F	Rmf @ T, F	1.2
96	Rsn/Rm	10.9
Rm, OHM-MTR	Corctn Fctr	0.98
3.9	SSP, -MV	17.6
@T, F	Rwe	0.67
43	Rw @ T, F	0.67
Rmf, OHM-MTR	Rw @ 75F	0.62
0.88	TDS	9007
@T, F		
96		

WELL NO.	SBU H-10	FRM NAME	Z-SAND
LOG DATE	11-15-81	DEPTH TOB FT	633
LOG TYPE	DIFSL	THKNS FM FT	50
TD, FT	2899	THKNS BED FT	50
BHT, F	100	SP, -MV	38
Rm, OHM-MTR	2.35	Tf, F	69
@T, F	75	Rsn, OM	24
Rmf, OHM-MTR	1.76	Rm @ T, F	2.5
@T, F	75	Rmf @ T, F	1.9
		Rsn/Rm	9.4
		Corctn Fctr	0.98
		SSP, -MV	37.1
		Rwe	0.55
		Rw @ T, F	0.53
		Rw @ 75F	0.49
		TDS	11535

WELL NO.	SBU F-5	FRM NAME	Z-SAND
LOG DATE	12-20-58	DEPTH TOB FT	640
LOG TYPE	EL	THKNS FM FT	55
TD, FT	2855	THKNS BED FT	55
BHT, F	104	SP, -MV	21
Rm, OHM-MTR	3.3	Tf, F	69
@T, F	70	Rsn, OM	27
Rmf, OHM-MTR	1.6	Rm @ T, F	3.4
@T, F	104	Rmf @ T, F	2.3
		Rsn/Rm	8.1
		Corctn Fctr	0.97
		SSP, -MV	20.4
		Rwe	1.19
		Rw @ T, F	1.57
		Rw @ 75F	1.45
		TDS	3671

WELL NO.	SBU F-6	FRM NAME	Z-SAND
LOG DATE	12-29-58	DEPTH TOB FT	645
LOG TYPE	EL	THKNS FM FT	55
TD, FT	2865	THKNS BED FT	55
BHT, F	105	SP, -MV	33
Rm, OHM-MTR	3.1	Tf, F	69
@T, F	60	Rsn, OM	32
Rmf, OHM-MTR	1.2	Rm @ T, F	2.7
@T, F	105	Rmf @ T, F	1.8
		Rsn/Rm	11.7
		Corctn Fctr	0.98
		SSP, -MV	32.2
		Rwe	0.61
		Rw @ T, F	0.60
		Rw @ 75F	0.55
		TDS	10224

WELL NO.	FRM NAME	Z-SAND
SBU J-16	DEPTH TOB FT	512
LOG DATE	THKNS FM FT	58
10-25-81	THKNS BED FT	58
LOG TYPE	SP, -MV	35
DIGL	Tf, F	67
TD, FT	Rsn, OM	68
2798	Rm @ T, F	2.6
BHT, F	Rmf @ T, F	1.9
98	Rsn/Rm	26.1
Rm, OHM-MTR	Corctn Fctr	0.99
2.35	SSP, -MV	34.5
@T, F	Rwe	0.61
75	Rw @ T, F	0.60
Rmf, OHM-MTR	Rw @ 75F	0.54
1.76	TDS	10394
@T, F		
75		

WELL NO.	FRM NAME	Z-SAND
SBU L-3	DEPTH TOB FT	615
LOG DATE	THKNS FM FT	60
1-24-59	THKNS BED FT	60
LOG TYPE	SP, -MV	21
EL	Tf, F	68
TD, FT	Rsn, OM	35
2843	Rm @ T, F	3.1
BHT, F	Rmf @ T, F	2.2
104	Rsn/Rm	11.2
Rm, OHM-MTR	Corctn Fctr	0.97
4.3	SSP, -MV	20.5
@T, F	Rwe	1.12
48	Rw @ T, F	1.41
Rmf, OHM-MTR	Rw @ 75F	1.30
1.5	TDS	4129
@T, F		
104		

WELL NO.	FRM NAME	Z-SAND
SBU M-13	DEPTH TOB FT	535
LOG DATE	THKNS FM FT	55
12-1-81	THKNS BED FT	55
LOG TYPE	SP, -MV	30
DISFL	Tf, F	67
TD, FT	Rsn, OM	35
2808	Rm @ T, F	2.8
BHT, F	Rmf @ T, F	1.1
93	Rsn/Rm	12.3
Rm, OHM-MTR	Corctn Fctr	0.96
3.2	SSP, -MV	29.3
@T, F	Rwe	0.41
59	Rw @ T, F	0.38
Rmf, OHM-MTR	Rw @ 75F	0.34
1.25	TDS	17154
@T, F		
58		

WELL NO.	FRM NAME	Z-SAND
SBU O-14	DEPTH TOB FT	640
LOG DATE	THKNS FM FT	48
12-30-81	THKNS BED FT	48
LOG TYPE	SP, -MV	28
DISFL	Tf, F	69
TD, FT	Rsn, OM	33
2904	Rm @ T, F	1.4
BHT, F	Rmf @ T, F	1.3
94	Rsn/Rm	22.8
Rm, OHM-MTR	Corctn Fctr	0.99
1.57	SSP, -MV	27.8
@T, F	Rwe	0.50
63	Rw @ T, F	0.48
Rmf, OHM-MTR	Rw @ 75F	0.44
1.37	TDS	13061
@T, F		
63		

WELL NO.	FRM NAME	Z-SAND
SBU O-11	DEPTH TOB FT	583
LOG DATE	THKNS FM FT	40
4-6-66	THKNS BED FT	40
LOG TYPE	SP, -MV	23
IEL	Tf, F	68
TD, FT	Rsn, OM	40
2830	Rm @ T, F	3.6
BHT, F	Rmf @ T, F	2.0
98	Rsn/Rm	11.0
Rm, OHM-MTR	Corctn Fctr	0.99
2.6	SSP, -MV	22.7
@T, F	Rwe	0.95
98	Rw @ T, F	1.10
Rmf, OHM-MTR	Rw @ 75F	1.00
1.45	TDS	5427
@T, F		
98		

WELL NO.	FRM NAME	Z-SAND
SBU M-10	DEPTH TOB FT	515
LOG DATE	THKNS FM FT	60
2-10-57	THKNS BED FT	60
LOG TYPE	SP, -MV	22
IEL	Tf, F	67
TD, FT	Rsn, OM	32
2840	Rm @ T, F	1.8
BHT, F	Rmf @ T, F	1.5
97	Rsn/Rm	17.6
Rm, OHM-MTR	Corctn Fctr	0.98
1.71	SSP, -MV	21.6
@T, F	Rwe	0.75
72	Rw @ T, F	0.78
Rmf, OHM-MTR	Rw @ 75F	0.71
1.1	TDS	7882
@T, F		
97		

WELL NO.	FRM NAME	Z-SAND
SBU R-12	DEPTH TOB FT	670
LOG DATE	THKNS FM FT	42
6-58	THKNS BED FT	23
LOG TYPE	SP, -MV	27
EL	Tf, F	69
TD, FT	Rsn, OM	30
2873	Rm @ T, F	3.0
BHT, F	Rmf @ T, F	2.1
102	Rsn/Rm	10.1
Rm, OHM-MTR	Corctn Fctr	1.01
2.6	SSP, -MV	27.4
@T, F	Rwe	0.86
80	Rw @ T, F	0.96
Rmf, OHM-MTR	Rw @ 75F	0.89
1.5	TDS	6168
@T, F		
102		

WELL NO.	FRM NAME	Z-SAND
SBU S-7	DEPTH TOB FT	650
LOG DATE	THKNS FM FT	50
3-25-56	THKNS BED FT	50
LOG TYPE	SP, -MV	22
EL	Tf, F	69
TD, FT	Rsn, OM	30
2790	Rm @ T, F	2.6
BHT, F	Rmf @ T, F	2.0
104	Rsn/Rm	11.4
Rm, OHM-MTR	Corctn Fctr	0.98
2.5	SSP, -MV	21.6
@T, F	Rwe	0.99
73	Rw @ T, F	1.17
Rmf, OHM-MTR	Rw @ 75F	1.08
1.88	TDS	5002
@T, F		
75		

METLAB Testing Services, Inc.

6825 East 38th Street Tulsa, Oklahoma 74145
(918) 664-7767

ATTACHMENT V

LETTER TRANSMITTING RESULTS OF WATER ANALYSES OF WATER SAMPLES FROM WATER WELLS DRILLED IN NW/4, SEC. 9-T25N-R6E

September 25, 1984

MLTS 84-3643

M.R. McComas and Associates, Inc.
1802 So. Main
Broken Arrow, OK 74012

Attn: Mr. Martin Schmidt

Dear Mr. Schmidt,

In accordance with your instructions, chemical analyses were performed on twenty-three (23) water samples from test hole drillings in Osage County submitted on September 24, 1984.

	Sample I.D. – Depths Sampled –	T.D.S. (mg/l)	Chloride (mg/l)
Lemsco-1	L-1:480-488A	7572	4425
	L-1:480-488B	8412	4956
	L-1:550-565A	13747	7965
	L-1:550-565B	13139	8142
	L-1:800-808A	11293	6549
	L-1:800-808B	11237	6903
	Pond: West of L-1	720	354
Lemsco-2	L-2:220-235A	19986	11682
	L-2:220-235B	19995	11328
Lemsco-3	L-3:500-515A	23424	13452
	L-3:500-515B	23502	13806
	L-3:560-578A	23807	13983
	L-3:560-578B	24928	13806
Lemsco-4	L-4:510-525A	3220	1593
	L-4:510-525B	3056	1416

METLAB

MLTS 84-3643

Lemco-5

Sample I.D.	T.D.S. (mg/l)	Chloride (mg/l)
L-4:710-725A	16326	9558
L-4:710-725B	16893	9381
L-5:510-525A	3740	1947
L-5:510-525B	3616	1947
L-5:710-725A	3668	1770
L-5:710-725B	3743	1770
L-5:790-805A	4150	2301
L-5:790-805B	4600	2301

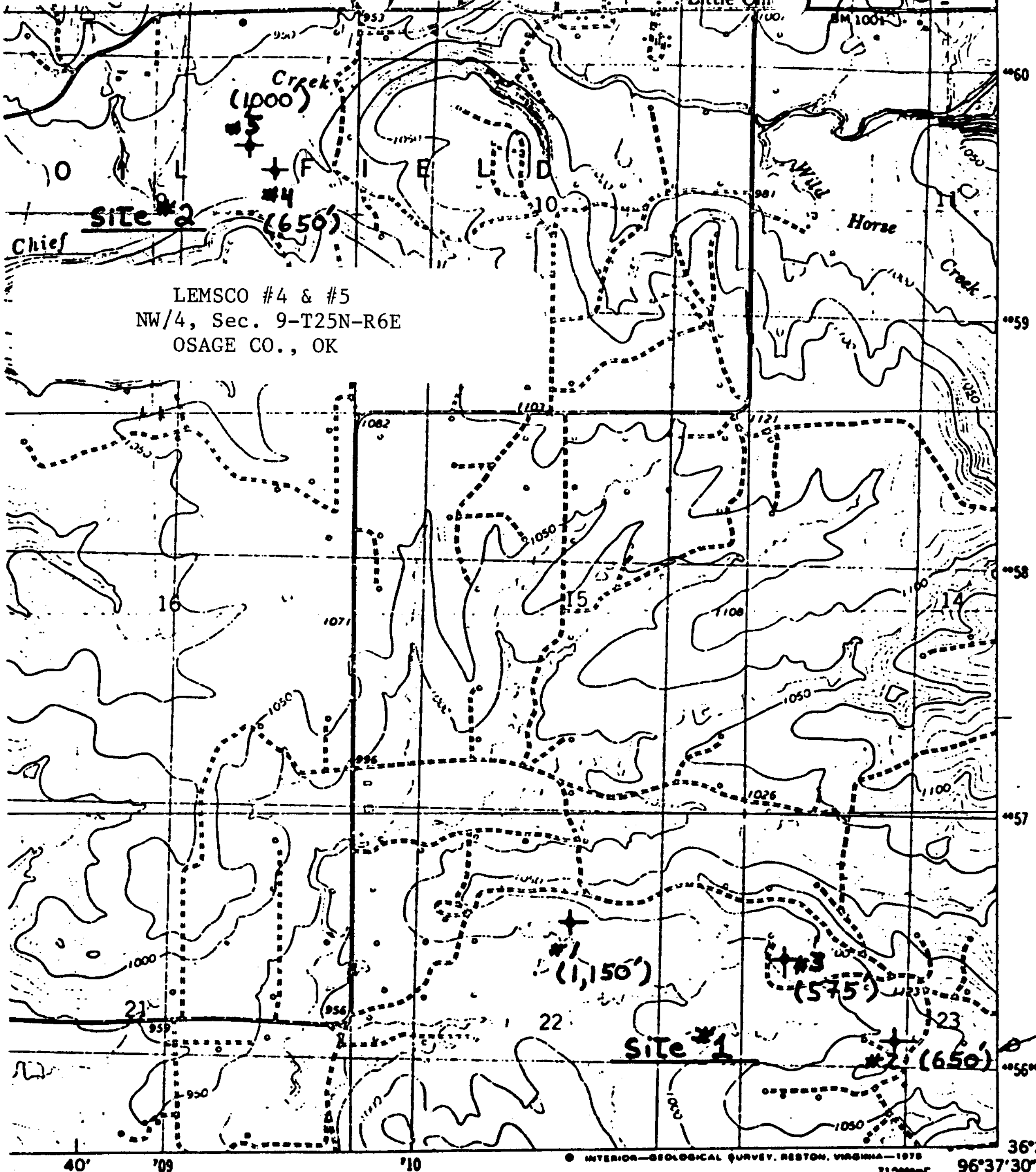
Sincerely,

METLAB TESTING SERVICES, INC.

Tony Mummolo

Tony Mummolo
Analytical Chemist

TM/sc



COMPLETED

Site #1 : Sec. 22, T25N, R6E (#1)
Sec. 23, T25N, R6E (#2,3)
→ Site #2: Sec. 9, T25N, R6E (#4,5)
SBU "P"
well #3

1 MILE

ROAD CLASSIFICATION

Primary highway, hard surface

Light-duty road, hard or improved surface

Secondary highway, hard surface

Unimproved road

Interstate Route U. S. Route State Route

(LUCY CREEK)

Figure 1. Target test well locations, Burbank, OK (1978).

Comparative Oil Well Water Analyses (South Burbank Pool)
Osage County, Oklahoma (Con.
Page 2

Description and Sampling Date	Depth	Gravity	Total Solids P.P.M.	Sodium and Potassium P.P.M.	Sodium and Potassium %	Calcium P.P.M.	Calcium %	Magnesium P.P.M.	Magnesium %
Eva Bean #6, 6-9-34	2838'	1.0965	127,984	37,400	29.22	10,498	8.20	947	0.74
" " #6, 6-27-34	2838'	1.0920	125,440	36,296	28.94	11,245	8.96	483	0.39
" " #6,		1.1161	158,007	45,683	28.91	12,882	8.15	1,561	0.99
Eva Bean #7	650'	1.0084	11,140	3,896	34.97	177	1.59	113	1.01
" " #7, 6-13-34	855'	1.0234	35,805	12,642	35.31	731	2.04	391	1.09
" " #7, 6-19-34	1170'	1.0936	129,091	40,030	31.00	7,071	5.48	1,961	1.52
" " #7	1170'	1.0913	127,492	39,785	31.21	6,798	5.33	1,903	1.49
" " #7, 7-4-34	2005'	1.1164	157,166	46,919	29.85	10,510	6.69	2,236	1.42
" " #7, 7-16-34	2595'	1.1207	168,182	49,600	29.49	11,845	7.04	2,346	1.40
" " #7	Bailed from bottom	1.1325	177,580	51,877	29.21	13,819	7.78	1,880	1.06
" " #7, 8-16-34	2879'	1.1361	179,092	52,026	29.05	13,891	7.76	2,117	1.18
" " #7, 8-17-34	2879'	1.1362	179,017	51,909	29.00	13,896	7.76	2,172	1.21
Eva Bean #8, 3-19-35	555'	1.0277	38,963	13,219	33.93	1,123	2.88	518	1.33
" " #8	650'	1.0073	11,028	3,783	34.30	272	2.47	127	1.15
" " #8	840'	1.0214	30,867	11,009	35.66	583	1.89	296	0.96
" " #8, 3-22-35	840'-60'	1.0205	30,157	10,690	35.45	632	2.09	288	0.95
" " #8, 3-23-35	880'-90'	1.0249	37,109	13,095	35.29	812	2.19	372	1.00
" " #8, 4-2-35	1170'	1.0916	126,162	39,080	30.98	6,931	5.49	1,933	1.53
" " #8, 4-4-35	1340'-50'	1.1012	136,873	42,113	30.77	7,954	5.81	1,976	1.44
" " #8, 4-11-35	1990'	1.1154	153,177	46,052	30.07	10,161	6.63	2,025	1.32
" " #8, 4-14-35	2180'	1.1189	156,533	46,999	30.02	10,443	6.67	2,068	1.32
" " #8, 4-19-35	2560'	1.1325	172,674	50,007	28.96	12,668	7.34	2,658	1.54

Description and Sampling Date	Chlorides P.P.M.	Chlorides %	Bicarbonates P.P.M.	Bicarbonates %	Sulfates P.P.M.	Sulfates %	Remarks
Eva Bean #6, 6-9-34	78,905	61.65	27	0.02	207	0.17	Oswego Lime (Bottom of Hole)
" " #6, 6-27-34	76,895	61.30	17	0.01	465	0.37	Carbonates 39 PPM Pipe Perforated at 2765'
" " #6,	97,639	61.80	33	0.02	209	0.13	Bailed from Bottom Hole Before Shot
Eva Bean #7	6,068	54.47	443	3.98	443	3.98	
" " #7, 6-13-34	21,775	60.82	240	0.67	86	0.07	
" " #7, 6-19-34	79,850	61.86	34	0.03	145	0.11	
" " #7	78,809	61.81	46	0.04	151	0.12	
" " #7, 7-4-34	97,470	62.02	16	0.01	15	0.01	
" " #7, 7-16-34	104,107	61.90	45	0.03	249	0.14	Oswego Lime. Iron present.
" " #7	109,838	61.85	33	0.02	142	0.08	Iron present
" " #7, 8-16-34	110,881	61.91	52	0.03	185	0.07	Bartlesville Sand Iron present
" " #7, 8-17-34	110,881	61.94	32	0.02	127	0.07	Bottom Hole Water After shot
Eva Bean #8, 3-19-35	23,359	59.95	126	0.32	618	1.59	Lime
" " #8	6,391	57.95	250	2.27	200	1.86	
" " #8	18,715	60.63	218	0.71	45	0.15	Iron present
" " #8, 3-22-35	18,296	60.67	213	0.71	38	0.13	
" " #8, 3-23-35	22,553	60.78	227	0.61	50	0.13	Iron present
" " #8, 4-2-35	78,120	61.92	64	0.05	34	0.03	Iron present
" " #8, 4-4-35	84,736	61.91	58	0.04	36	0.03	Iron present
" " #8, 4-11-35	94,885	61.95	34	0.02	20	0.01	Suitcase Sand. Iron present
" " #8, 4-14-35	96,972	61.95	25	0.02	25	0.02	Iron present. Mixed with 1990' sand water
" " #8, 4-19-35	107,200	62.08	12	0.01	129	0.07	Iron present. Water sand.

ATTACHMENT VI
SBU "T" QUARTER SECTION
WATER ANALYSES

COMPARATIVE OIL WELL WATER ANALYSES (SOUTH BURBANK POOL)
OSAGE COUNTY, OKLAHOMA

Description and Sampling Date	Depth	Gravity	Total Solids P.P.M.	Sodium and Potassium P.P.M	%	Calcium P.P.M.	%	Magnesium P.P.M.	%	Chlorides P.P.M.	%	Bicarbonates P.P.M.	%	Sulfates P.P.M.	%	Remarks
Eva Bean #1, 3-17-34	890'-910'	1.0201	27,288	9,831	36.03	464	1.70	232	0.85	16,515	60.52	220	0.81	26	0.09	
" " #1, 3-17-34	990'	1.0203	27,212	9,780	35.94	491	1.80	226	0.83	16,515	60.69	184	0.68	16	0.06	
" " #1, 3-25-34	1200'	1.0876	118,448	37,023	31.26	6,339	5.35	1,718	1.45	73,275	61.86	51	0.04	42	0.04	
" " #1, 4-14-34	2442'	1.1138	148,519	42,631	28.70	11,470	7.72	2,192	1.48	92,018	61.96	23	0.02	185	0.12	
Eva Bean #2, 4-8-34	590'	1.0033	3,640	1,292		11		8		1,557		644		106		Carbonates 22 P.P.M.
" " #2, 4-11-34	790'	1.0163	21,564	7,753	35.95	388	1.80	179	0.83	12,947	60.04	281	1.30	16	0.08	
" " #2, 4-19-34	1110'	1.0906	121,908	38,073	31.23	6,512	5.34	1,798	1.48	75,438	61.88	53	0.04	34	0.03	
" " #2, 4-22-34	1300'	1.0887	120,205	37,648	31.32	6,320	5.26	1,773	1.48	74,352	61.85	65	0.05	47	0.04	
" " #2, 4-22-34	1305'	1.0817	111,072	35,111	31.61	5,611	5.05	1,590	1.43	68,660	61.82	62	0.06	38	0.03	
" " #2, 4-22-34	1400'	1.0948	127,687	39,959	31.29	6,816	5.34	1,824	1.43	79,021	61.89	29	0.02	38	0.03	
" " #2	1952'	1.1087	144,138	43,685	30.31	9,162	6.36	1,949	1.35	89,252	61.92	42	0.03	48	0.03	
" " #2	1958'	1.1097	146,958	44,640	30.38	9,311	6.34	1,943	1.32	90,967	61.90	44	0.03	53	0.03	
" " #2	2486'-90'	1.1284	168,763	50,293	29.80	11,380	6.74	2,377	1.41	104,632	62.00	39	0.02	42	0.03	
" " #2, 5-22-34	2805'	1.0091	11,870	3,616	30.46	771	6.50	120	1.01	7,175	60.44	116	0.98	72	0.61	Drilling water
Eva Bean #5, 4-17-34	600'	1.0014	3,415	1,158	33.91	17	0.50	25	0.73	1,396	40.88	712	20.85	107	3.13	
" " #5, 4-22-34	830'	1.0220	30,569	10,997	35.98	492	1.61	288	0.94	18,491	60.49	254	0.83	47	0.15	
" " #5, 4-30-34	1135'	1.0973	129,260	40,133	31.05	7,090	5.49	1,930	1.49	80,030	61.91	54	0.04	23	0.02	
" " #5, 5-9-34	1955'	1.1254	165,814	50,115	30.23	10,744	6.48	2,190	1.32	102,680	61.92	24	0.01	61	0.04	
" " #5, 5-17-34	2505'	1.1271	166,239	48,070	28.92	12,414	7.47	2,435	1.46	103,109	62.02	32	0.02	179	0.11	
Eva Bean #6, 4-25-34	635'-50'	1.0061	5,852	1,342	22.93	675	11.53	118	2.02	3,452	58.99	247	4.22	18	0.31	
" " #6, 5-4-34	840'	1.0264	36,294	12,890	35.52	770	2.12	338	0.93	22,123	60.96	121	0.33	52	0.14	
" " #6, 5-16-34	2000'-2205'	1.0675	90,852	27,303	30.05	6,065	6.67	1,172	1.29	56,233	61.90	27	0.03	52	0.06	
" " #6, 5-27-34	2600'	1.1172	168,406	50,684	30.10	11,255	6.68	2,124	1.26	104,299	61.94	8	-	36	0.02	ou
" " #6,	2737'	1.0924	111,230	32,486	29.21	9,308	8.37	698	0.63	68,312	61.41	63	0.06	363	0.32	After plug drilled
" " #6, 6-9-34	1800' in 2838' hole	1.0926	123,764	36,337	29.36	11,352	9.17	14	0.01	75,544	61.04	00	-	272	0.22	Carbonates 40 P.P.M. Hydroxides 205 " Alkaline condition due to cement work